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Thesis by

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[UNIVERSITY OF EDINBURGH]
[THESIS FOR THE DEGREE OF
DOCTOR OF MEDICINE]

Malaria Fever.

by

Capt. Crawford Kennedy

R.A.M. Corps.

[1708]



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Introduction.

In submitting a Thesis on Malla Fever to the University of Edinburgh for the Degree of Doctor of Medicine, I should like to state briefly my reasons for my choice of a Subject.

It has been my fortune to have almost an unique experience of Malla Fever both in its clinical and bacteriological aspects. I arrived in Malla in May 1901 and served there till September 1906. During most of that period I was stationed at the Military Hospital Killebrae and being in charge of Acute Fever Wards saw most of the cases of Malla Fever which passed through, amounting to two to three hundred annually. In 1903, I contracted the disease myself and was invalided home for three months.

In 1904 when the Royal Society's

Mediterranean Fever Commission was started, I assisted the members in their clinical investigations and in the end of the year was appointed a Member. I served on the Commission till its close in September 1906 and being as it were a permanent member, carried on the work during the absence of the others ~~also~~ for six months in each year. Inasmuch therefore as I was the only working member with the exception of Dr. Launuit who remained in the Commission from start to finish I trust I may lay claim to some of the "Original Research" demanded of one who desires to submit a Thesis.

A large part of the Research work summarised in Part-I is my own work and as full references are given this may be appreciated.

Part-II is entirely the result of personal observation and the facts are mainly derived from notes and charts of 250 Cases.

R. A. M. College
April 1908.

Harford Kennedy
Capt. R.A.M.C.

MALTA or MEDITERRANEAN FEVER.

UNDULANT FEVER (Hughes)

SEPTICAEMIA OF BRUCE (Trambusti)

PRÉCIS.

PART I gives a short account of the History of the Fever and the development of the Work of Research. The results of the recent research are summarised and the main facts of the Etiology brought out. The Cause and the Modes of Infection are discussed.

PART II is a Clinical Description of the Disease as it occurs in Man.

PART III discusses Immunity and Prophylaxis and the result of prophylactic measures on the Epidemiology of recent years. Conclusion.

P A R T I.

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DEFINITION.

Malta or Mediterranean Fever is an invasion of the system by the Micrococcus Melitensis of Bruce of the nature of a septicaemia, producing a remittent fever of long duration and tending to relapse, profuse sweats, and local affections especially of the joints and nerves.

HISTORICAL NOTE.

My purpose here is merely to give a very short account of the development of the work of Research. Anyone who desires to study the history, nomenclature and bibliography of this disease prior to the year 1897 should refer to Hughes' exhaustive account.⁽¹⁾

The History of Malta Fever is practically the history of its study in the Mediterranean and more especially in Malta. It is but natural that the Maltese should object to this unenviable notoriety and especially to the name "Malta Fever", and there has been a good deal of consternation at the facts that have been brought to light by the recent researches. But it is extraordinary that what Hughes says of "well educated Maltese physicians who have informed him quite recently

(1) Hughes. Mediterranean, Malta or Undulant Fever. 1897.

that this Undulant or Mediterranean Fever was not known in Malta ten years ago, but that it originated when the new drainage was laid down in 1885" is still true of a very large section of the Maltese population, and this opinion is frequently aired in the local papers. There can be, however, no doubt that this fever is an old established one in Malta. In the 18th century it is described as a low form of fever prevalent in the wards of the Great Hospital of the Knights of St. John (now the Military Hospital, Valletta). In the beginning of the 19th century (1800-1810) Sir William Burnett gives an accurate clinical picture of this disease, which occurred amongst the sailors when in port. In the time of the Crimea a great increase is noted due to the increase of susceptible individuals in the Garrison.

It was not till 1859, however, that it was described with any accuracy, when Marsden published an account of the Fevers in Malta in the Army Medical Blue Book and named this disease Mediterranean Remittent or Gastric Remittent Fever. In 1886 Bruce discovered the specific micrococcus and in 1887 published his paper in the "Practitioner".

In 1896 Mediterranean Fever was classified in the "Nomenclature of Diseases" (Roy. Coll. Phys. London) as a distinct disease "in consequence more especially of representations made by officers

of the Medical Department of the Army". (memo. of sub-committee).

In 1897 Surg. Capt. Hughes published his exhaustive monograph, and in the same year Wright and Semple described the technique of the serum diagnosis of Malta Fever, and the differentiation between it and Enteric.

In 1903 in consequence of the very alarming proportions that the disease was assuming amongst the naval and military population in Malta and the consequent excessive invaliding, special attention was directed to its investigation by medical officers of both services. (1).

In 1904 the Royal Society at the request of the Admiralty, the War Office, and the Civil Government of Malta appointed a Committee under the chairmanship of Colonel D. Bruce, F.R.S., R.A.M.C., to superintend the investigation of the disease. The Committee appointed a working Commission consisting of naval, military and civilian members, who carried out their researches in Malta during the years 1904 to 1906. The work of this Commission has been published in seven volumes of Reports.

(1). Kennedy. M.M. in Synovial fluid. R.A.M.C. Journal 2, 1904, p. 178.
Shaw and Gilnour. M.M. in Blood. Naval Blue Book.

This note, short summary as it is, can hardly be considered sufficient without some reference to the theories that have previously been put forward as to the Cause and the Epidemiology of the Disease: it will also emphasise the advance made within the last five years.

In 1810 Burnett assigned the cause to Marsh miasma coming from the marshy lands at the top of the harbours. These however have long since been drained. Later writers assume it to be due to insanitary conditions of the island and of its harbours. The description of the Grand Harbour as "one huge Cesspool"⁽¹⁾ could not have been much exaggerated before the new scheme of drainage was laid down, when all the sewage that was able to drain away from Valletta and the three cities found its way there. It is described as a "filth disease"⁽²⁾ and as "dirt fever"⁽³⁾. Naval writers frequently observe that ships lying at the top of a creek (in harbour) or in dock for any length of time produce more cases of fever: this observation still held good up to the year 1906.

Hughes produces a mass of evidence against

(1). Hughes page 64

(2). Notter 1876

(3). Sipps. 1890.

insanitation - "sewer gas and faecal emanations". It is interesting to note that the turning up of contaminated soil; viz. in laying down drains and building new houses or barracks, has often been associated with an outbreak of this fever amongst those living near. Several instances of this kind came under the writer's own experience.

The consensus of opinion was therefore in favour of faecal pollution being the cause and that infection was conveyed by some means or other through the air.

A mosquito theory⁽¹⁾ was thereupon advanced and gained among others some very ardent supporters⁽²⁾. It is remarkable that no one was able to trace any connection between the incidence of the disease and the water or food supplies⁽³⁾ and it was not till the summer of 1905 when it was discovered that goats⁽⁴⁾ and consequently their milk, were infected with the specific microbe that any advance was made in the epidemiology of the disease.

(1) Zammitt. Journ. State Medicine. 1902. 399

(2) S.G. Allen. Journ. R.A.M.C. 1904 i. 699.

Ross and Levick. B.M. Journ. 1905 i. 710.

(3) Hughes.

R.W. Johnstone. M.F. Reports II.

A.M. Davies. M.F. Reports IV.

(4) Zammitt. Horrocks. Kennedy. M.F. Reports V.

GEOGRAPHICAL DISTRIBUTION.

Though it is undoubtedly a fact that Malta Fever is specially prevalent around and in the Mediterranean, still these are by no means its limits, and within recent years undoubted proof has been given of its existence all round the world. The following is a list of places in which it is said to be endemic.

Europe. Malta and Gozo, Cyprus, Crete, Sicily,

Corsica and Sardinia, Balearic Isles.

Spain - Gibraltar ("Rock fever").

Italy - Rome, Naples and south coast.

Greece - Athens, Cephælonia.

Turkey - Constantinople, Smyrna.

Africa. North Africa - Aden, Alexandria,

Port Said, Suakim, Blue Nile, Cairo,

Suez, Tunis, Algiers.

South Africa - Cape Colony, Orange

River Colony, Phillipolis, Transvaal.

Asia. Palestine - Jerusalem.

China - Hong Kong, Shanghai.

India - Punjaub etc.

America. Mississippi Valley.

South America - Venezuela, Brazil.

West Indies - Cuba, Porto Rico.

Phillipine Islands - Fiji.

Canary Islands.

Mediterranean Region.

A case has also been reported in England⁽¹⁾ at Dover in a gunner who had never been abroad.

NOMENCLATURE.

"Mediterranean Fever" is the official nomenclature (nomenclature of Diseases) but for short and on account of its association with Malta it is usually called "Malta Fever", and this latter term I shall use, as a rule, throughout this Thesis. Recently Prof. Trambusti of Messina has addressed a letter⁽²⁾ to the Medical Profession in Britain suggesting the name "Septicaemia of Bruce", in order to obviate the stigmatising of Malta. For such a purpose the name "Undulant Fever" suggested by Hughes would be more convenient. It is not my purpose to recall the old terms used but would merely remind one of the popular Gibraltar name - "Rock Fever".

THE MICROCOCCUS MELITENSIS.

The specific organism of Malta Fever was first described by Bruce in 1887⁽³⁾.

Morphology:- It is a minute spherical coccus varying in size from 0.3μ in stained to 0.4μ in fresh specimens. It may be slightly oval and some have described a "bacillary" form which would appear to be either involution forms or

(1) Mangin. Journ. R.A.M.C. 1904 ii, 729.

(2) B.M. Journal Nov. 23 1907. p. 1546.

(3) Practitioner. 39, 1887, 161.

cocci which are in a stage of fission. It is readily emulsified in salt solution and rolls off the needle into the solution in clouds. In hanging drop preparations the cocci are arranged singly or in pairs, sometimes in chains of three or four. In broth cultures chains of eight to ten are sometimes seen. In a hanging drop blood serum cultivation I have watched the gradual development of a chain of thirty to forty individuals. There is no capsule, and spore formation has not been observed. There is no true motility but very vigorous Brownian movement is present in hanging drop preparations. Gordon⁽¹⁾ claims to have demonstrated flagella, but no other observer has been able to confirm his observation.

Staining:- The micrococcus does not retain stain by Gram's method, but is easily stained by ordinary basic aniline dyes. The best stains are Carbol Fuchsin and Thionin Blue.

Culture:- The optimum growth is obtained aerobically at a temperature of 37°C. on a medium with a reaction of + 8 to + 10 (Eyre's scale). It is able to grow anaerobically but very slowly and the limits of temperature at which growth takes place are from 6°C. to 45°C. The extremes

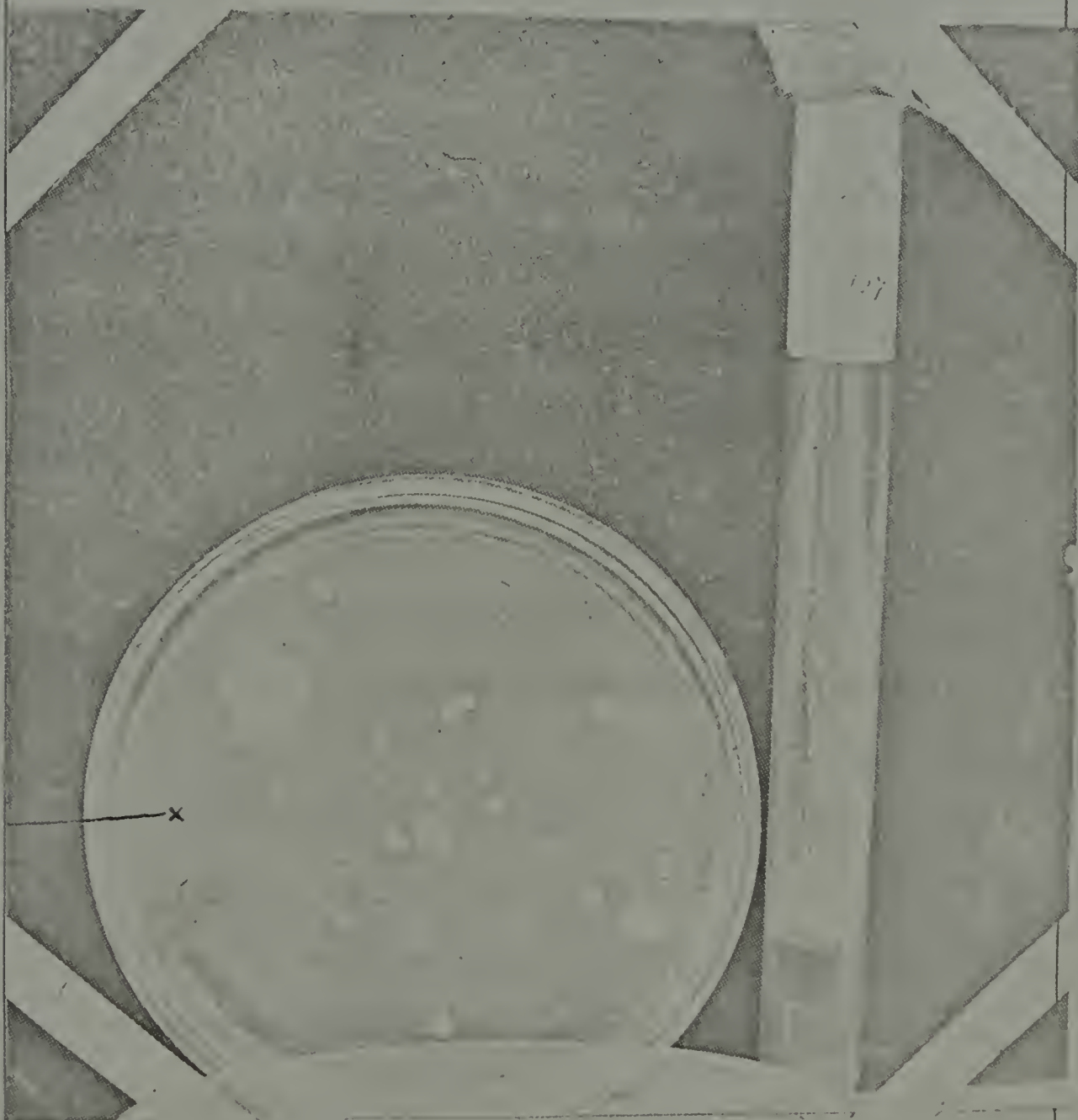
(1) Lancet i. 1899. 688.

of reaction of the media between which growth takes place are according to Eyre, - 7.5 and + 15. As a rule growth of the micrococcus is very slow. A primary culture from pathological material is not visible to the naked eye before the third or fourth day. If the material planted is grossly infected, a growth may be just visible after 24 to 36 hours. Subcultures will yield a good growth in 24 hours.

Cultural Characteristics.

Agar Plates. The size of the individual colonies depends on the number present in the plate. If the plate is very crowded the colonies remain very small, except those growing just at the edge, and give a ground glass appearance to the surface. If the colonies are few in number they may attain a diameter of 3, 4 or 5 m.m. As a description of a colony I can not do better than quote Eyre in a recent paper.⁽¹⁾ "Individual colonies are round, nearly circular in shape; surface colonies, convex to pulvinate, occasionally umbonate; deep colonies biconvex, edge entire structure finely and regularly granular, surface smooth. In the centre of each colony is a darker portion of sharply defined oval shape better seen in the deep than in the surface colonies. No lines grooves or other structural markings can be seen, although in old

(1) Eyre. Journ. R.A.M.C. 1907, i, 113.

Photo. 1Culture of M. Melitensis.

Agar Slope - showing pure culture of M. Melitensis
direct from spleen of fatal case of Malta Fever.

Agar Plate - showing colonies of M. Melitensis and
a few contaminations from kidney of same case.
Incubated 4 days.

colonies the central portion may become more coarsely granular or even grumose. Colonies when young are translucent. After about four days' growth they become opaque, whitish with a slight opalescence by reflected light and pale yellow to pale amber by transmitted light. With age the colour passes from rich amber to light brown or even dirty slate brown".

Agar Stab - a diffuse growth.

Nutrose Agar - same as peptone agar but growth is more luxuriant, and may appear in 16 hours. According to Eyre, the optimum medium is ~~all~~ one prepared from ox-serum.

Nutrose-litmus-agar is a convenient medium for purposes of isolation. The litmus is unchanged.

Nutrose-glucose-litmus-agar⁽¹⁾ is of considerable use in isolating *M. Melitensis* from material (e.g. urine) containing many acid producing cocci.

M. Melitensis does not ferment glucose, and its appearance remains the same as detailed above.

This was the medium by means of which the micrococcus was first isolated from urine. It was curious to note the effect of an excess of acid producing organisms on the growth of *M. Melitensis*. If the plate was entirely overgrown with acid

(1) Horrocks. Reports M.F. Commission I. 5.

organisms *M. Melitensis* was not recovered; but if a few large colonies of alkali producing colonies were also present and were vigorous enough to neutralise the excess of acid in their immediate neighbourhood, thus preserving a zone of neutral medium round about them, tiny colonies of *M. Melitensis* might be found in this zone, nestling against and protected by their more hardy and vigorous companions. The colonies in these circumstances were very translucent, developed no colour and remained very small (0.25 m.m.).

Gelatine stab and slope. (22°C.) Growth very slow. No liquifaction.

Broth. Diffuse growth. No surface pellicle.

In five to seven days a deposit formed and some clearing of the broth.

Glucose-peptone (1 per cent) growth, no acid, no gas.

Lactose-peptone " " " "

Saccharose-peptone " " " "

Starch-peptone " " " "

Litmus milk - no clotting - production of alkali..

Peptone and Salt - Indol not formed

Proskauer's and Copaldi's No. 1. No growth.

" " No. 2. Growth. No change.

Neutral red - unchanged after 48 hours at 37°C.

After 5 days, a yellow colour appeared at surface.

Potato - Moist transparent film gives a copious growth when scraped; formation of chains⁽¹⁾ marked. Yellowish coloured growth after making surface of potato alkaline by the addition of sodium carbonate.

MacConkey's Bile Salt broth - growth - reaction unchanged.

Nitrate broth - growth - no reduction of nitrates.

Irregular Cultural appearances.

In isolating the organism from urine one sometimes came across colonies which instead of being smooth on the surface, presented a wrinkled appearance, due to a nodular development. This may be due to the colony having developed from a clump of cocci which had been agglutinated in the urine as the urine contains agglutinins. (Fig. B.)

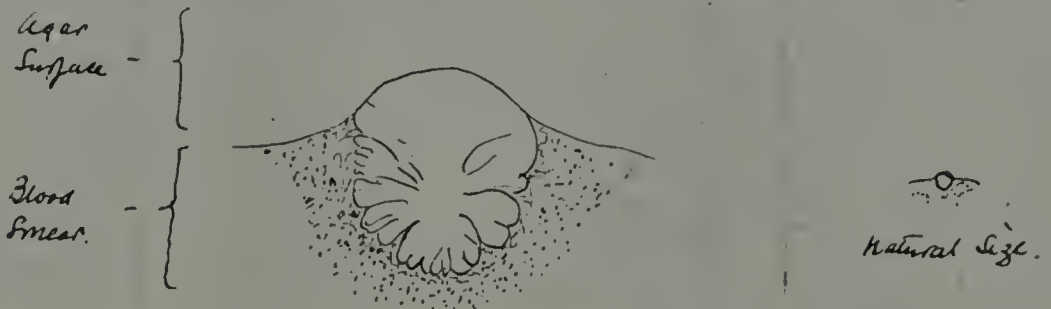
Colonies grown from patients' blood which has been smeared on plates usually present a radiated appearance due to the growing colony having to push away the surrounding layer of blood. The growth naturally takes the line of least resistance and throws out rounded projections. The fissures and depressions between these projections give a radiated appearance. (Fig. A.)

(1) Horrocks. Rep. M.F.C. I. 6.

Irregular Cultural Appearances.

Fig. A.

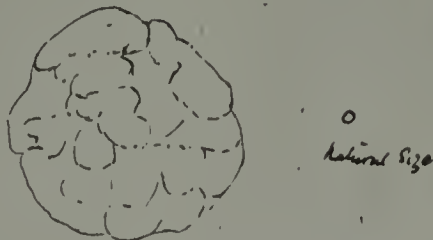
Growth of *M. Mclintensis* in Blood which has been smeared on an agar plate. - Surface view.



Note! Effect on growth, of surrounding blood.
Resistance to growth has produced radiated appearance.
The portion lying outside the blood has an unbroken margin and is clear and homogeneous.

Fig. B.

Colony of *M. Mclintensis* from urine grown on nutrient agar plate.
Surface view.



To show wrinkled appearance of surface due to nodular growth.

IDENTIFICATION OF M. MELITENSIS.

The characteristics on which one depends chiefly for its identification are:-

1. Does not stain by Gram's method.
2. Growth on peptone agar.
3. Growth in glucose - litmus-peptone or
on glucose-litmus-agar.
4. Growth in milk (with litmus)

and 5, the fact that it is agglutinated by a high dilution (1 - 1000) of an immune serum.

Resistance.

The *M. Melitensis* is fairly resistant.

Dry Heat at 90° - 95°C . and } kill it in 10 minutes.
Moist Heat at 57.5°C .

It resists Dessication on woollen fabrics for
from 3 weeks to 3 months.

Sunlight at 130°F (54.4°C) kills in one hour.

By Antiseptics it is killed readily.

1 in 100 Phenol and 1 in 2000 Hydrog. Perchlor.

kill in 10 minutes. Clayton Gas (S.O_2 1.2%)

requires $4\frac{3}{4}$ hours and .7 per cent liquid Sulphur
Dioxide 5 hours.⁽¹⁾

Hydrochloric acid has a decided lethal action in
low dilutions (0.5 per cent) varying with the
strength of the emulsion used in the experiment.

When emulsified and added in equal parts to
artificial gastric juice (.32% Pepsin, .02% H.Cl.)
M. Melitensis is slowly killed, but when added
in milk will live for a long time. In an
experiment I easily recovered it after five days.

Vitality.

The vitality of the *Micrococcus* is consider-
able, and the following facts have been es-
tablished by various workers.⁽²⁾

(1) Wade. Report to Local Government Board
"Experiments on Sulphur Dioxide"
No. 232, May 7, 1906.

(2) Horrocks, Shaw, Bassett Smith, Eyre, Kennedy.

It may live for:-

Three weeks in sterilised normal urine.
dry sterile sand.
dry coverslips.
unsterilised manured soil.

Four weeks in dust from streets of Valletta.

Five weeks in unsterilised normal urine.

Six weeks in sterile Malta Fever urine.
sterile sea water.

Seven weeks in unsterile sea water.
unsterilised Malta Fever urine.

Eight weeks in sterilised tap water.

Nine weeks in sterilised manured soils.

Ten weeks in unsterilised tap water.

Thirteen weeks in sterile Malta soils.

An important practical point is that it may be recovered from the urine of a patient three weeks after it has been excreted or from the clothes on which it has dried.

On artificial media it may retain its vitality for a very long time - one to two years. Eyre reports a successful recovery from an agar culture 830 days old. In successfully recovering it from a litmus milk culture for a period of nine months (284 days) I noted that at one period it lost its typical character. During the 5th month it was necessary to use comparatively large quantities of the milk ($\frac{1}{4}$ cc.) to obtain a growth at all, and it seemed to be dying out. The subcultures obtained at this period were

atypical in that they refused to emulsify. These atypical cultures were preserved and three months later were subcultured. When a very scanty growth of a micrococcus in all respects typical was obtained. At the same time the cultures from the original milk (now 7 to 8 months old) regained their former typical character. At no time were contaminations present in the milk or the subcultures.

Inoculation and Virulence.

In Man there have been quite a number of accidental laboratory inoculations (and two voluntary) and with exceedingly small doses. The result has invariably been a typical attack of Malta Fever after an incubation period varying from five to sixteen days. Inoculation is followed by the appearance in the blood serum of substances which clump the Micrococcus when added to the diluted serum in emulsion.

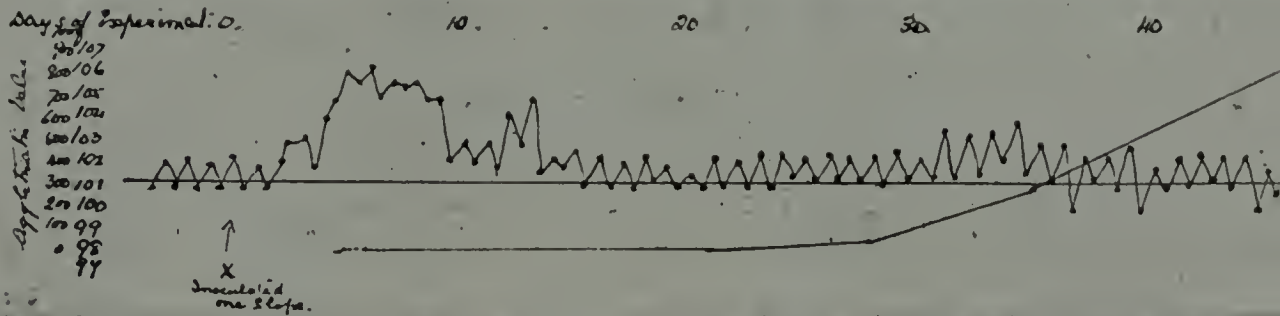
The agglutinins so formed are absolutely specific and therefore the diagnosis of Malta Fever is greatly facilitated. The method of applying the agglutination test and its value as a diagnostic is fully discussed in the clinical Part under "Diagnosis". An interesting fact is that these agglutinins appear in the secretions and excretions of those suffering from Malta Fever, viz. urine, milk, tears. Dr. Zammit of Malta informed me he was able to demonstrate the agglutinins in the tears of an infant who was crying and kicking and from whom he had not been able to extract sufficient blood.

In Animals: subcutaneous inoculation produces very slight clinical symptoms. Even monkeys, who are the most susceptible, may not show the slightest indisposition unless the dose has been

exceptionally large or of a virulent strain.

The following chart illustrates the effect of the subcutaneous inoculation of one agar slope on a monkey (*Macacus Rhesus*)

Chart I.



The temperature⁽¹⁾ begins to rise on the 3rd or 4th day and reaches its maximum from the 6th to the 10th day after inoculation. The agglutination appears about the 5th day (vide agglutination curve in the chart). It will be noticed that there is an attempt at a relapse about the 30th day. This is not usual in animals, but is a marked feature of the disease in man. The monkey was killed on the 49th day and the only things to be noted were slight enlargement of the spleen, which was dark and soft, and enlargement of the axillary and femoral glands. M. Melitensis was obtained from the heart's blood, spleen (profuse), liver (few), kidney (one colony in two plates), mesenteric

(1) "The Temperature of the Normal Monkey" by Eyre and Kennedy. Proc. Physiolog. Soc. March 23, 1907.

The Temperature in Malta works out at 38.43°C, or 101.15°F.

glands, and Femoral and axillary glands (in profusion).

Horses, goats, dogs, rabbits, guinea pigs and rats rarely show symptoms after subcutaneous inoculation, but the temperature rises and the serum reaction appears. See following charts.

Chart 2.

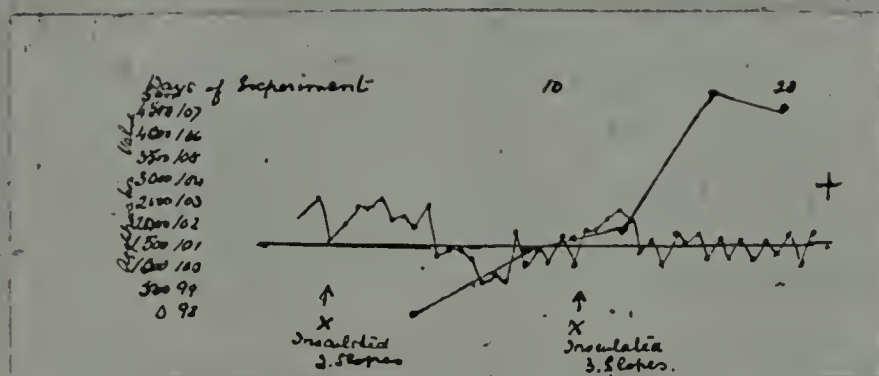


Chart 2 represents the temperature curve and the agglutination curve as the result of inoculating a small black short-haired terrier with, on the first occasion, two slopes of a virulent human spleen culture of *M. Melitensis*, and on the second occasion three slopes. The constitutional disturbance was practically nil. The agglutination was not tested often enough in this case to show the negative phase after the second inoculation, but it is indicated.

The animal was killed on the 22nd day. The Post Mortem appearances noted were:- great redness and injection behind the right shoulder (site of inoculation), marked enlargement of right axillary lymphatic gland, enlarged spleen. *M. Melitensis*

was recovered from spleen (profuse), inguinal glands (profuse), right axillary gland (very profuse), and left axillary gland (profuse), but not from the heart's blood or the bile.

Chart 3.

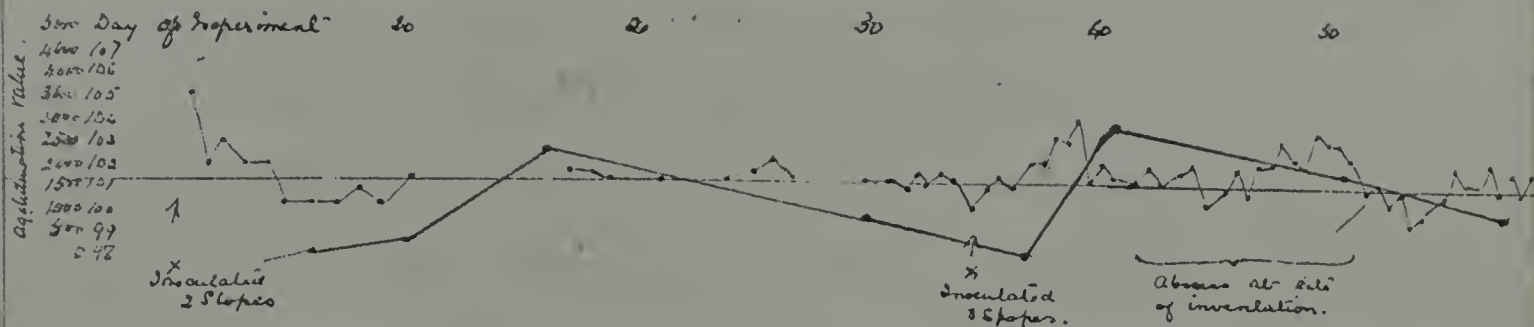


Chart 3 represents the same experiment on a similar dog, but the second inoculation was postponed till the 37th day and the post mortem till the 60th. The irregular temperature after the 2nd inoculation was due to an abscess which evacuated itself. At the post mortem *M. Melitensis* was recovered from inguinal and mesenteric glands only, and could not be found in the blood, spleen, bile, or even from the wall of the healed abscess, which was sterile.

If the animal be killed and examined post mortem, the spleen will be enlarged and soft and the lymphatic glands as a whole enlarged. The micrococcus may be recovered from the blood, spleen, liver, kidneys, bile, lymphatic and mesenteric glands, more or less according to the severity of the infection and the duration of the experiment.

It is exceedingly important to examine the lymphatic glands⁽¹⁾ in cases where the infection has taken place some time previously, as these organs are the last for the *M. Melitensis* to leave and many times were the only organs which contained the organism.

The virulence for animals may be much increased by the intravenous, or intraperitoneal injection, and especially by the intracerebral inoculation of the organism, and by the rapid passage from guinea pig to guinea pig through a series intracerebral inoculation may so increase the virulence as to cause the death of a guinea pig in five days or less with a dose of .25 milligrams of culture.⁽²⁾

It is found that in these acute infections of animals the organism is excreted in the urine, and by way of the alimentary tract in the intestinal mucus and faeces, and also that a very acute septicaemia is produced; the blood may contain tens of thousands of *M. Melitensis* per cubic centimetre. This was found to be of great use in the experimental infection of mosquitoes, and biting flies (stomoxys). These biting insects

(1) Kennedy. Rep. M.F.C. IV. 94.

(2) Eyre. Rep. M.F.C. II. 67.

were frequently infected experimentally, and the result of many observations proved that the organism appeared to multiply for the first 24 or 48 hours in the stomach or crop and was then rapidly eliminated, being easily recovered from the droppings in an unchanged and virulent state. There is no evidence that it penetrates to the salivary glands.

Besides being eliminated by means of the urine and the faeces the organism is also eliminated in the milk of experimentally infected goats. A subcutaneous inoculation given to a goat produces a rise of temperature from normal (101° to 102° F.) to 106° or 107° F on the following days, which gradually falls to normal in the next four or five. There are no obvious clinical symptoms. The agglutination appears about the 4th or 5th day. The appearance of the micrococcus in the milk is uncertain and is usually delayed for some weeks or even months. After inoculation the micrococcus may exist in the blood for 8 months.

EXISTENCE OF THE MICROCOCCUS IN NATURE.Saprophytic Existence.

By referring to the remarks on "Vitality" and "Resistance" the existence in nature apart from a living host may be surmised, but on only one occasion and that hardly a fair example has it been found independently of its host, viz. in the dust on the top of a cupboard in our laboratory in Malta (by Eyre). All attempts to isolate it from dust, earth, sewage, air, water, (fresh and salt) etc. collected from likely places have been unsuccessful.

Parasitic Existence.

Besides man the following become naturally infected in endemic areas. Horses, mules, goats, cows, sheep, dogs, cats and mosquitoes.

Malta Fever in Man is fully dealt with under the "Clinical Study". The points to be emphasised here are:- The existence in large numbers and the persistence of the organism in the blood; its elimination in the urine, faeces, and milk, and the occurrence of ambulatory cases, which act as "carriers" of infection by a persistent Bacteriuria. The micrococcus has never been isolated from the sweat or the saliva, though I have isolated it in large numbers from the salivary glands.

It will be as well to take this opportunity

of saying something about the Bacteriology of the Blood in view of what is to be said about transmission by means of mosquitoes.

That the micrococcus exists in the blood of those suffering from Malta Fever was first demonstrated by Shaw and Gilmour at the Naval Hospital Malta in 1903-4, and was subsequently frequently observed by many of us.

Technique. The usual precautionary measures are carried out and the syringe after being washed out in sterile citrate solution is passed into the median basilic vein; the blood when drawn may be mixed with broth or, as there is no bactericidal action, planted direct on to agar plates. In the earliest stages of the disease and when the temperature is very high such a simple procedure as sterilising the ear or finger, pricking, picking up the drop of blood on a sterile platinum loop and passing the loop over an agar plate or putting it into broth is sufficient.

For enumeration of numbers present, known quantities of blood may be spread over agar plates, and the resulting colonies counted. But the best method probably is to dilute 1 cc. of blood in 9 cc. of broth in a test tube and from this tube to make successive dilutions into other tubes by

means of a graduated pipette. Tubes containing from 1 to .000001 cc. blood are thus obtained and are incubated for 3 to 4 days to enrich. Plates are then inoculated from each tube and it is noted what is the smallest quantity of blood from which a growth is obtained.

The organism exists in the blood from the earliest stage of the disease (having been obtained on the 2nd day) to a very late period (e.g. 300th day) according to the course of the disease.

Its presence in large quantities bears a distinct relation to the height of the fever and the stage of the disease viz:- as many as 10,000 cocci per cc. blood have been observed in the height of the first attack. There is also a diurnal variation corresponding to the evening rise of temperature. But it may still be found in considerable quantities ^{during} ~~among~~ convalescence when the temperature is practically normal.

Malta Fever in Animals.

Goats:- That goats become naturally infected was first demonstrated by Zammit⁽¹⁾ and Horrocks⁽²⁾ in Malta in the summer of 1905, who in testing a small herd of six goats bought for experimental work found that five of them gave an agglutination.

(1) Zammit. "A Preliminary note on the Blood of Goats suffering from Malta Fever" Reports M.F. Com. III. Part VI.

(2) Horrocks. "A Preliminary Note on Goats as a means of Propagation of Mediter-Fever". Reports M.F.C. II. Part VII.

reaction to *M. Melitensis*. Thereupon the writer⁽¹⁾ examined 161 goats from eight different herds and found that 84 or 52 per cent. reacted. Later on the total examined was brought up to 331, and the number found to react, 138 or 41 per cent. The agglutination value of each specimen was tested in dilutions 10, 20, 40, 60, 80 and 100 and the maximum reaction of the 138 is represented by the following figures, 35, 35, 12, 15, 2, 39 in order of respective dilutions. It was extraordinary how often the paradoxical reaction was present, and had not each specimen been examined up to 100 dilutions as a matter of routine many reactions must have been missed in the lower.

It was then found impossible to make any more observations as the owners of the goats refused to allow their goats to be bled. At the same time investigation with the blood, urine and milk of the five goats in the experimental herd mentioned above was carried on, and the following table gives the result of these examinations and remarks on the condition of the goats. It should be noted that all these goats were considered by their owners to be "out of milk" and therefore not likely to be used for milking purposes, although

(1) Kennedy. "Examination of Goats' Blood for :
Reaction to *M. Fever*".
Reports M.F.C. III. Part VIII.

the milk of Nos. 2 and 6 was quite normal in appearance.

Table 1.

No. of Goat	Agglut. React.	<u>Recovery of</u> <u>M. Melitensis</u> <u>Blood.Milk.Urine</u>			Appearance of Milk	General appearance.
1.	$\frac{1}{40}$	nil.	+	+	thin serous	Healthy. Temp. N.
2.	$\frac{1}{100}$	nil	+	nil	normal	Healthy Temp. N.
3.	$\frac{1}{100}$	nil	+	nil	serous	Healthy. Temp. N.
5.	$\frac{1}{100}$	+	+	+	thick jelly-like	In poor condition.
6.	$\frac{1}{300}$ naked eye, immediate.	+	+	nil	normal	In poor condition. T.N.

* indicates that M.M. present in profusion.

The examination of the milk of the 331 goats mentioned above was then undertaken and it was found that 10 per cent. contained M. Melitensis. Sometimes as many as 30 or 40 per cent of the total numbers in one herd had M. Melitensis in their milk⁽¹⁾. As I have mentioned above it was soon found impossible to obtain any more goats' blood

(1) Horrocks and Kennedy. "Goats as a means of Propagation of Mediterranean Fever". Reports M.F. Commission IV. page 37 to 70.

owing to the hostility of their owners, and what I had already obtained required the exercise of much tact and patience. Fortunately we found that we could dispense with the blood and rely on the agglutination test applied to the milk (Zammit's test)⁽²⁾. Although the agglutination was not always found in the milk when present in the blood serum it was always present when *M. Melitensis* was being excreted in the milk. We found that 72 per cent of those giving serum reaction also gave a milk reaction, and that none of the remaining 28 per cent (no milk reaction) excreted *M. Melitensis*. Therefore, so far, the milk reaction was a better indication of the presence of the microbe; but, further, it was found that the degree of serum agglutination was really no indication of the excretion in the milk, as the milk might contain large numbers of cocci while the blood reaction only reached a dilution of 1 in 10, and on the other hand a serum reaction of 1 in 100 did not by any means indicate excretion. Observations lasting over several months in some goats with an immediate complete naked eye reaction in 1-100 gave no indication of excretion. Indeed I would go so far as to say that some cases may

(2) Horrocks and Kennedy. "Goats as a means of Propagation of Mediterranean Fever". Reports M.F. Commission IV. page 45.

occur where the milk reaction is present and the serum reaction is so low as to be missed in 1-10⁶ dilution.

The technique employed for the milk agglutination was first of all microscopic agglutination in equal parts of milk and prepared emulsion on a slide kept in a moist chamber for 12 hours. At the end of that time the fatty part of the milk had collected in the centre, leaving the edges and the bottom clear. The milk was prevented from turning sour by the addition of one drop of 40 per cent formalin to 10 cc. milk. After further experiments, however, it was found that sedimentation gave excellent results - by using a 1-10 dilution of milk added in equal parts to the prepared emulsion, giving a final dilution of 1-20, drawn up in sedimentation tubes and allowed to stand 24 hours. This gave excellent results, and in no case where sedimentation proved negative was *M. Melitensis* recovered from the milk. We were thus able to carry on the investigation, and being backed up by the Sanitary Authorities in Malta who could invoke the aid of the Law in collecting samples for examination we proceeded to collect samples of milk in small sterile bottles, and after testing for agglutination plated them out on petrie dishes. However in the

spring of 1906 the hostility of the milkmen became more pronounced, and they refused even samples of milk. This resulted in a prosecution by the Sanitary Authorities, and on the conviction of the offenders, the milkmen in a body went on strike in the latter end of May. The strike lasted for 10 days, and during that time Valletta was deprived of its fresh milk supply. This turned out to be the best thing that could have happened for the British Naval and Military population. As the milkmen had broken their contracts with the Barracks and Hospitals, the Authorities had to obtain condensed or tinned milk, and were readily persuaded by their medical representatives to continue the issue of the preserved article to the troops and not to renew the fresh milk contracts after the strike was over. How striking the result was in the improved health of the troops will be fully demonstrated later, and up to this day the British Naval and Military Garrison of Malta has depended on its supply of preserved milk.

The appearance of the infected goats suggests nothing. Sometimes one appeared to be off its food and lazy, and later on when the milk was drying up, perhaps a short cough, loss of flesh and a thinning of the coat might be apparent. But indeed it was often noted that the goat with

the highest agglutination value in a herd was one of the best milkers and gave 5 or 6 pints a day. A good average milk production is 4 to 5 pints a day, and the following figures represent the number of pints per day given by ten goats whose serum reacted completely in 1-100 dilution and over - 3,3,5,2,6,2,6,4,2,2 $\frac{1}{2}$ - an average of 3.5.

The Physical and Chemical composition of the milk remains unchanged when the goat is in full milk.

Pregnancy is not affected by the infection, but goes on unchanged. The kid is strong and healthy and shows an agglutination in its serum. In the instances so far observed the kid has given no signs of an active infection and the agglutinins present in its blood are probably transferred from the mother.

There is no doubt that infection may occur in utero in the human being⁽¹⁾ but it must be extremely rare in the goat, probably explained by its natural immunity, and the paucity of the micrococcus in its blood.

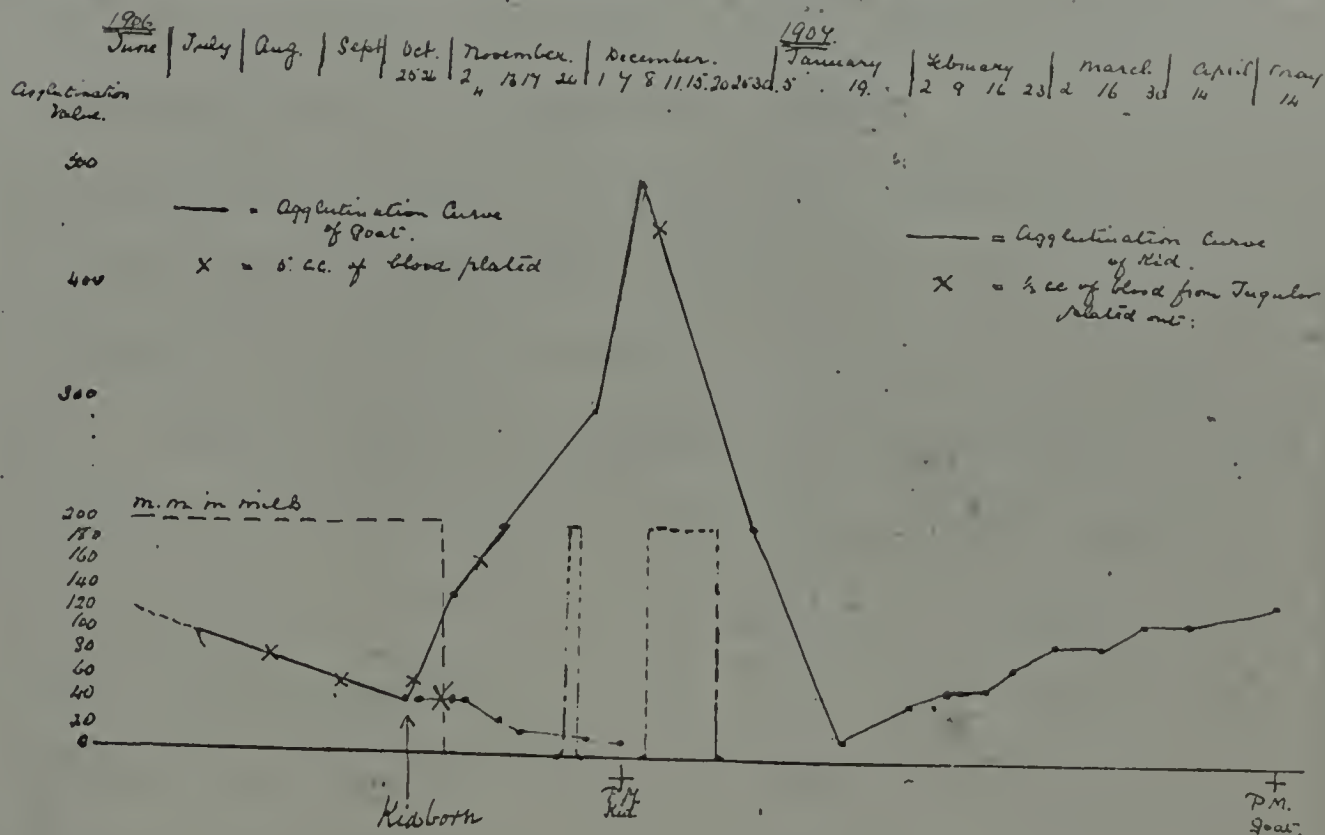
The following case illustrates the presence of the agglutinins in the blood and the absence of active infection in the kid.

(1) Major Williams. R.A.M.C. Journal. 2.1907.
p. 59.

In June 1905 I found in one of the herds a pregnant goat reacting immediately in dilution of 1-100, and giving a profuse growth of *M. Melitensis* from its milk. It was only giving one pint of milk, which was used to feed the kids of the herd. This goat was purchased and kept under observation. On July 17th the milk still contained great numbers of *M. Melitensis*, and was examined weekly with the same result till October 23rd. On this day the milk still contained *M. Melitensis* in profusion, and as "full time" approached the quantity of milk had diminished until it was now a thick gelatinous yellow stuff. On August 14th and Sept. 14th 5 cc. of blood were drawn from the jugular vein and cultured but no *M. Melitensis* was recovered. On the 25th October the serum was found to react completely in 1-30, incompletely in 1-50 and very slightly in 1-100 dilutions (written $+ \frac{1}{30}$, $\pm \frac{1}{50}$, trace $\frac{1}{100}$). In the afternoon of the same day the kid was dropped in splendid condition, strong and healthy. On the next morning the kid's blood was examined and found to give identically the same reaction as the mother's, viz. $+ \frac{1}{30}$, $\pm \frac{1}{50}$, trace $\frac{1}{100}$. The respective sera of mother and kid were then examined periodically and compared and the following chart strikingly represents the

course taken by each.

Chart 4.



The dotted columns represent the excretion of *M. Melitensis* in the milk of the goat. No count of actual numbers was made.

It will be observed how the agglutination value of the goat at once rises rapidly, suggesting a re-infection or a renewed activity on the part of the infecting organism in the mammary gland, whereas that of the kid remains stationary for a few days and then rapidly falls. Blood was taken from the jugular vein of the kid seven days after birth and cultured, but no *M. Melitensis* was recovered. There was therefore no sign of active infection of the kid; but in order to complete the experiment the kid was killed on the 7th

December, 43 days after birth and a careful post mortem examination made. The carcass was fat and in splendid condition; cultures from the following organs were made:- spleen, four plates; Inguinal glands, 6; mesenteric glands, inferior 5, superior 5; liver 2; kidneys, 3; thymus gland, 1; and heart's blood four tubes. They were all sterile and no *M. Melitensis* was present.

Another point is brought up by these observations, viz:- the kid in spite of orders to the contrary was allowed to be suckled by its mother on several occasions on which *M. Melitensis* was present in the milk, and notwithstanding did not become infected. This observation along with others would indicate that these kids are immune to infection by their mothers' milk. They are not immune to subcutaneous inoculation.

The further history of the goat is interesting. It was kept under constant examination, the blood for agglutination and the milk for the organism being examined weekly. On several occasions 5 cc. of blood was drawn from the jugular and cultured without recovering the organism. The chart describes the course of the agglutination and the excretion in the milk. It will be noticed how the excretion in the milk ceased soon after parturition but reappeared and then again disappeared, and how its final dis-

appearance corresponds to ^{the attainment of a high point followed by} a rapid fall in the agglutination value of the blood serum. During the last four months the organism was not recovered from the milk but a steady rise in agglutination is noted, and on May 14th 1906, eleven months after the first observation, the goat was killed and a careful post mortem examination made. *M. Melitensis* was recovered only from the mesenteric glands and then only to the extent of three colonies in one plate. Nothing was found in the spleen, again emphasising what I have previously observed as to the prolonged residence of the organism in the glands.

The excretion of *M. Melitensis* in milk of goats is uncertain and irregular. It is uncertain in its appearance during infection and irregular in amount.

The method of isolating it from the milk is very simple, as goats' milk passed direct into sterile bottles contains very few saprophytes, and indeed one could practically depend on getting sterile cultures. (Always provided that the goat was otherwise healthy, as suppurative mastitis is not uncommon). Ten cub. centimetres of the milk is centrifuged for a short time and a small quantity from the bottom drawn up into a capillary pipette, from which one to three drops are dropped

on to a nutrose agar plate; an L shaped glass rod spreader is used to distribute it over the surface and then passed over two other plates. If it is desired to calculate the number of cocci present in a given quantity of milk it is not centrifuged, and one drop ($=.035$ cc.) is put on each of 3 plates and spread over the surfaces. The plates are incubated 4 days and the colonies on each plate counted if few in number and an average taken; if very crowded a small sector is counted and the total calculated. The quantities which may be excreted are beyond comprehension, and the accompanying photograph gives an idea of the appearance of a plate culture from a grossly infected specimen of milk.

The following table illustrates the irregularity and uncertainty and quantity of the excretion during a period of four months .

Photo. 2.Milk Culture Plate.

10 cc. of goat's milk centrifugalised and three drops of the deposit spread on a glucose-nutrose-litmus-agar plate.
Incubated 4 days at 37°C.

Photo by Staff Sergt. Rossiter R.A.M.C.

Note:- The purity of the culture.

Table 2.

Number of *M. Molluscis* per cubic centimetres in milk
of injected goat.

Goat	No 105	No 111	No 112		No 105	No 111	No 112
May 7 th	nil	—	—	Continued			
" 10.	30,000	10,000	100	June 26	nil	12,000	2,600.
" 15	nil	6,000	nil	" 30	30	23,000	1,000
" 22.	nil	30,000.	nil	July. 3	nil	6,170	66
" 26	nil	6,000.	4,000	" 5.	nil	4,000	66
" 29.	nil	15,000.	nil	" 19.	10,000	—	—
" 31.	nil	30,000	100	" 21.	—	730.	nil
June 2.	nil	5,700.	nil	" 24.	8,300.	—	—
" 5.	nil	12,000	30	" 26.	—	1,000	nil
" 9.	nil	20,000	nil	" 27.	—	4,800	—
" 12.	nil	3,400	66	" 28	nil	—	—
" 14.	5,000	8,000	100	" 31.	—	30	nil
" 16	nil	6,000	30	Aug. 2.	1,200	—	—
" 19	nil	30,000	700	" 4.	—	2700	nil
" 21.	nil	2,400	2,000	" 7.	5,300	—	—
" 23	nil	2,700	3,200	" 14	nil	nil	nil
" 26	nil	13,000	30,000	" 18.	6,600.	10,000	nil

— = no observation

The number 30,000 is merely a round number indicating the impossibility of counting the colonies and in most cases is greatly below the actual number present; in some cases 300,000 or 3,000,000 per c.c. would be nearer the mark.

This table demonstrates that the excretion tends to be intermittent and to come in gushes. The mammary gland besides being one of the last organs in the body for the organism to disappear from, is an ideal spot for its growth; and when the gland is in an active state the organism by its accumulation probably acts as a stimulant, thus producing a reaction evidenced by a flushing

process and a gush of cocci. The organism may accumulate again and again and so cause a prolonged stimulation of the gland, possibly accounting for the well-known fact that the Maltese goat is second to none in its milk production, and the length of time during which it remains in milk. After such a flushing the organism may disappear altogether (see table 2, Goat 112, June 21st to 30th), and this may be due to the presence of sufficient antibodies in the system to assist the flushing process by killing out any residue left. A reference to Chart 4 (p. 34) will bear out this suggestion; here there is evidence of a large production of antibodies coinciding with the final disappearance of *M. Melitensis* from the milk.

The excretion in the milk appears at^a varying time after infection. The earliest I have seen it is six to seven weeks after, but probably it does not usually make its appearance for from three to eight months. The following case is interesting:- A goat belonging to the Commission was infected in September 1904, and at no time up to January 1906 was *M. Melitensis* observed in its milk; it was then "dry" and was therefore impregnated. In July 1906 two kids were dropped

and three days after, *M. Melitensis* appeared in the milk and remained consistently present till September 24th when it was slaughtered. In this case the organism was not recovered from the spleen, kidneys, or lymphatic glands.

I would now enphazise the points which to my mind appear to have an important bearing on the epidemiology of the disease in man.

The mammary gland is the last organ to become infected, and provides an ideal culture medium for the growth of the organism, which may remain in the glandular substance for an indefinite and prolonged period.

The presence of the organism probably stimulates the gland both in respect of the quantity and duration of its secretion.

Renewed activity of the gland after parturition may be accompanied by a renewed reproductive activity on the part of the organism.

The organism may be eliminated by a process of flushing assisted by an increase in the system of specific antibodies.

In order to get a good supply of milk in the summer the majority of the goats are impregnated about November. The great rise in the incidence of the disease in man during the months of May,

June, July to its climax in August may thus to some extent be explained.

MILK PRODUCTS.

At this point it is necessary to say something about the presence of the microorganism in milk products. As practically no native butter is consumed in the island it is not necessary to consider butter. The chief products used are cheese and ice-creams.

Cheese:- This is made by adding acid or rennet to the milk and the whey drained away through open basket-work moulds in which the curd sets. The cheese is ready for consumption next day. The organism can be readily isolated from cheese made from infected milk up to 48 hours, in spite of the high acidity, which may be as high as + 80 or + 90. (see also "urine" in "Clinical study"). After 48 hours the multiplication of lactic acid and other bacteria outstrips the *M. Melitensis* and renders its recovery almost impossible. In the process of making the cheese the organisms get caught in the curd - the whey contains very few organisms - and so are ready concentrated in the cheese. In the same way the cream of the milk contains more organisms than the skimmed portion.

Ice creams:- These are greatly in demand in the hot weather and are sold at little stalls at most of the street corners as well as at all the cafés. They are prepared in two ways. (a) by freezing a flavoured custard of milk and eggs, previously heated to 80° or 90°C . and (b) by freezing flavoured milk to which may be added cream. The former is more expensive and on that account probably less in vogue. Heating to 80° or 90°C . would of course kill the microorganism - as was found to be the case. In the second variety the micrococcus is easily recovered from the melted mixture in cases where infected milk has been used.

How do goats become infected?

Goats can be experimentally infected by inoculation (subcutaneously etc.), by rubbing infected milk into cutaneous abrasions, by simple contact with infected ones, and by feeding with infected milk or food mixed with infected dust (urine). All attempts to transmit infection by means of mosquitoes and biting flies (e.g. stomoxys, which abound in all goat stalls) have failed.

It seemed to us that the most likely was Cutaneous Infection by means of the goat-herd's hands. He uses a little milk from one goat to lubricate his hands before milking several other goats. If he should use an infected milk in the first instance, he passes it to the next udder and by the process of milking rubs it into any scratches or abrasions that may be present. Slight injuries and the bites of insects are common on the udders. The stomoxys for instance feeds voraciously, and when it falls off or is pulled off a little bead of blood comes welling up. The udders are specially liable to injury and abrasions on account of their size and unwieldy nature. It is quite a common sight to see a goat laboriously proceeding along the road an inch thick in dust, and having to lift each hind leg in succession over its greatly enlarged udder, which may be

only two or three inches from the ground.

Infection by the mouth would appear to be not quite so important, but when we consider that thousands of goats roam the streets of Valletta and pick up all the garbage they can find - a piece of brown paper is evidently considered a great delicacy quite irrespective of what it may contain -, and that the Maltese as a whole are anything but sanitary in their habits, one is forced to suppose that a certain amount of infection may be contracted in this way. There is no doubt that contact with infected goats is an important way and that the intervention of biting insects or of the goat-herd's hands is unnecessary.

That goats become infected in other places besides Malta and are the cause of the disease in man has been proved in Gibraltar⁽¹⁾, India⁽²⁾, Egypt and Orange Free Colony⁽³⁾.

The other animals that become infected can be dismissed in a few words.

Sheep: These are rather important in Malta as they are used largely by the country people for their milk. A very great proportion of those

(1) Horrocks. Reports M.F. Commission V. page 54.

" Journal R.A.M.C. 1907. i. page 426.

(2) Lamb and Pai. Scientific Memoirs. Government of India. 22. 1906.

(3) Strachan. South African Medical Record. Dec. 10th, 1906.

Photo. 3.

Goats returning from Valletta after the morning milking for their midday siesta.

Photo. 4.

Method of milking.

The goats are driven through the streets and milked at the customers' doorsteps.

Photo. 5.

Strada Stretta, Valletta - A favourite rendezvous for goats. By midday this street becomes very filthy.

Note the enlarged udders X

Photo. 6.

A Domestic Scene!

examined were found to be infected and to excrete the organism in their milk.

Cows. There are very few in Malta and they have to be stall fed practically all the year round.

Thirty three⁽¹⁾ were examined and ten gave an agglutination reaction. Two were found to be excreting *M. Melitensis* in their milk.

Mules and Horses: have been found to give the agglutination reaction in many instances⁽²⁾ but confirmation by isolation of the specific organism has not been obtained. In the beginning of 1906 I received information that nine mules had been imported to Malta from Sicily by the Army Service Corps. These I examined and found that none reacted to *M. Melitensis* above a dilution of 1-10. Six months later I re-examined them and found that two gave the reaction in 1-50, two in 1-20, and the remainder as before. In that period they showed no symptoms of illness.

Dogs⁽³⁾. In 1905 I examined 114 stray dogs found in Valletta and its suburbs for the serum reaction to *M. Melitensis*. Six gave an incomplete reaction in 1-10 dilutions, six complete in 1-10 and three

(1) Shaw. Reports M.F.C. IV. page 23.

(2) Kennedy. Reports M.F.C. IV. pages 86-91.
and Reports M.F.C. VI, pages 103-107.

(3) Kennedy. Reports M.F.C. IV. page 85.

complete in 1-30. Of these 15 dogs 14 were examined post mortem and *M. Melitensis* was recovered from one only - whose blood had reacted in 1-30. The organism was obtained from the mesenteric glands only. The total number of dogs in Malta and Gozo is at least 40,000, and in 1904 alone 3410 stray dogs were seized and destroyed by the police. There is every reason to suppose that the organism is eliminated by dogs in the same way as by other animals, and these facts speak for themselves in proving another probable source of infection.

Cats. Of 22 cats examined, 5 gave the serum reaction in 1-30 dilutions and from one of these latter the organism was recovered in very small quantity from the mesenteric and lymphatic glands only⁽¹⁾. (Compare dogs.)

Rats. About 150 rats were examined and though a few gave incomplete reactions no recovery of the organism was made post mortem. It was found on inoculating rats that the appearance of the serum reaction was uncertain and in fact usually not developed.⁽²⁾

Biting Insects.

Mosquitoes. That mosquitoes may become infected

(1) Shaw. Reports M.F.C. V. page 39.

(2) Reports M.F.C. VI. page 102.

with the organism in natural circumstances was proved by Horrocks and myself⁽¹⁾ in 1905. I made a collection of the various species to be found in the Hospitals and Barracks throughout the island and found that they consisted of *Culex Pipiens*, *C. Fatigans*, *C. Spathipalpis*, *Stegomyia Fasciata*, and *Acartomyia Zammitii* (which breeds in the pools of concentrated salt water on the rocks along the coast). We then dissected 896 mosquitoes ($H = 275$, $K = 621$) and planted out on petrie dishes their stomachs and contents of blood. *M. Melitensis* was obtained from four mosquitoes:- three *Culex Pipiens* containing 34, 100, and 4 colonies of *M. melitensis* on their respective plates, and one *Stegomyia Fasciata* with 24 colonies. One of these was caught in a room specially arranged for mosquito experiments with infected monkeys, and the other three were caught in the Malta Fever Wards of the Military Hospital Valletta, the Naval Hospital, and the Civil Hospital respectively. Out of the 896, about 450 were caught in places presumably infected, viz. wards containing Malta Fever patients in the acute stages, so that less than 1 per cent. of mosquitoes caught in infected places were found to contain the organism.

(1) Major Horrocks and Capt. Kennedy.- "Mosquitoes as a means of Dissemination of Mediterranean Fever". Reports M.F.C. IV. 70-82.

Photo. 7.

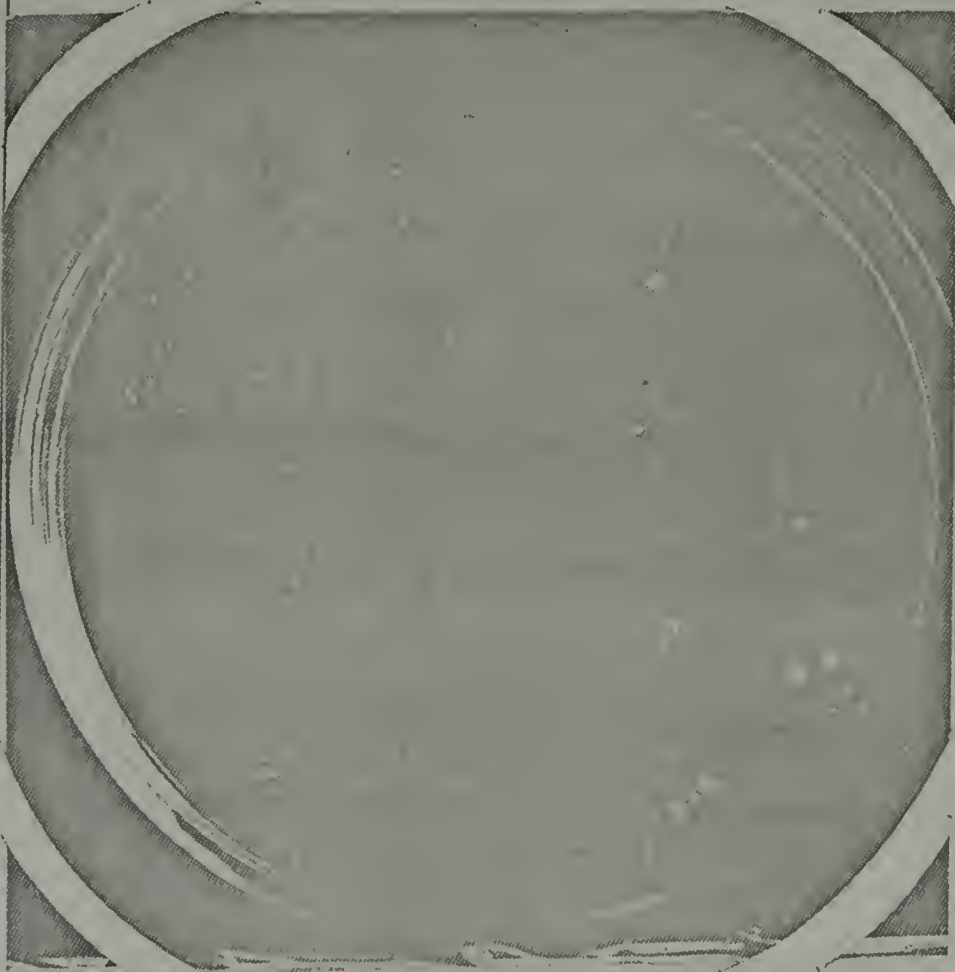
Blood from the
Stomach of a
Culex Pipiens
caught in the
Naval Hospital.
Bighi, Mallo.

Plated on glucose-
lactose agar

Incubated 4 days
at 37°C.

Mosquito dissected and
plated by Major
Horrocks, R.A.M.C.

Note:- 100 colonies *M. kullitensis*. Linear mark where colonies have
been picked and subcultured for verification.

Photo. 8.

The same as
above Photo
but blood taken
from a *Stegomyia*
fasciata caught
in Military Hospital
Colletta.

Dissected and
plated by Capt. J. J.
McKenna, R.A.M.C.

Note:- 24 colonies *M. kullitensis*. easily distinguished by pearly and
globular appearance.

The organism isolated from these mosquitoes proved virulent for monkeys and was typical in every respect.

Photographs of two of the plates are inserted.

No other insects were found to contain the Micrococcus, though I examined many Stomoxys Calcitrans, Bugs, Fleas and Sandflies.

MODES OF INFECTION.

It is well known that the M. Melitensis is one of the most dangerous for the laboratory worker; and that it has again and again been demonstrated how readily it can be absorbed through the tiniest prick or abrasion. One of the last victims to this mode of infection, was the late Professor McFadyean, who unfortunately succumbed to the disease. In one instance the infection obtained access through the unbroken mucous membrane of the conjunctiva into which a speck of living emulsion had splashed (Shaw).

Therefore excluding laboratory infection we have to deal with the following factors in the transmission and spread of infection:-

- (1) Direct conveyance by means of mosquitoes.
- (2) Excreta of human beings, animals, and insects.
- (3) Infected milk and its products.

What part each of these factors plays in the transmission of infection and in what degree man

is susceptible to the different modes of entrance must now be discussed.

(1). Conveyance by mosquitoes:- We know that the blood of patients in the acute stage contains enormous quantities of the micrococci, that mosquitoes occasionally get infected naturally, and that the disease can be contracted through the bite of an infected mosquito - instance the two following cases.

Experiment ⁽¹⁾ A. On October 1st 1905 while Major Horrocks was examining a monkey infected by feeding, the Maltese attendant was bitten by a mosquito which was caught and dissected and its stomach contents plated out. It was found to contain *M. Melitensis*. On the same day as the mosquito was caught the attendant's blood was carefully examined for reaction to *M. Melitensis* with a negative result. His temperature was also taken and found normal, he also stated that he was perfectly well. On October 11th he complained of feeling ill and returned to his home in the country, on the 18th he was found to have fever and his serum gave immediate agglutination with *M. Melitensis*. He developed a severe attack of Malta Fever which incapacitated him for three months.

Experiment⁽¹⁾ B. Mosquitoes (*Culex Pipiens*) collected from the Sanatorium (mostly convalescent Malta Fever patients) were placed in a cage and applied to a monkey every night for a period during October 1905.

The cage was applied eleven times and I consider that about 500 mosquitoes had a chance of biting; the last application was on October 31st. The serum test was applied systematically and on November 12th a faint agglutination was present, on the 19th it was still present; but afterwards disappeared. On Dec. 31st however a faint reaction re-appeared and on January 7th 1906 there was a more or less complete reaction in half an hour in 1-20 dilution. It was still the same on January 10th and 12th, and on January 24th, fearing that the reaction was again disappearing I chloroformed the animal and made a careful post mortem examination. The glands in the femoral and axillary regions were enlarged and more numerous than usual, the spleen and other internal organs were normal. The whole of the spleen was cut up and cultured and cultures were also made from the liver, kidney, mesenteric, femoral and axillary glands. *M. Melitensis* was recovered from the

(1) Kennedy. "Further Mosquito Experiments".
Reports M.F. Commission IV. page 185-187.

femoral and axillary glands only; all the other organs were sterile.

The animal was under careful observation during the whole experiment and could not have contracted the infection by other means than by the mosquito bite.

These two experiments (the first quite unforeseen) proved the possibility of such a mode of infection, but they are the only ones out of many failures. Taking this in conjunction with the fact that we could never trace the organism to the salivary glands of the mosquito, we came to the conclusion that any transmission from an infected to an uninfected person by means of a mosquito must be of a mechanical nature, that is to say that after feeding on infected blood the mosquito may retain some of the germs in its proboscis and inoculate the next person it feeds on with these, or possibly some of its infected excrement may be rubbed into the puncture by the scratching of the person bitten. When a mosquito feeds it usually "milks" its abdomen with its hind legs and leaves two or three drops of excrement round about the place punctured.

Everything therefore points to the conclusion that although transmission by means of mosquitoes is possible, it must in reality occur very occasionally.

(2) Excreta of human beings and animals.

These sources of infection may come in contact with the human subject directly (man to man) or indirectly through the medium of dust or filth or water.

It has been proved by contact experiments with monkeys that infection can be contracted only when the contact with the infected animal has been complete and that when the contact is limited to skin with skin only and all possibility of excretal contamination excluded no infection takes place. Further, that when food is contaminated with the urine of a Malta Fever patient, infection takes place.

This applies equally to the human subject - and in discussion I would divide this subject into two parts, i Direct Contact and ii Indirect Contact.

i. Direct Contact:- Under this heading comes the intimate relationship of the nurse and the patient, and still more so that of man and woman in sexual congress.

(i) Nursing. Our experience⁽¹⁾ in Malta up to and including the year 1905 was that men of the

(1) Kennedy. "Malta Fever in the Military Hospital, Valletta, during the years 1897-1904".

Journal R.A.M. Corps. 4. 1905. pp. 634-646.

also Kennedy. "The Incidence of Malta Fever amongst those employed in the Military Hospital, Valletta, Malta, during the year 1905".

Journal R.A.M.C. i. 1906. pp. 408-422.

R.A.M. Corps and men of the Sick Berth Staff in the Naval Hospital were more liable to the disease than men in other branches of the Services, and this was naturally put down to nursing. On the other hand though hundreds of Malta Fever cases yearly were invalided home to our Naval and Military Hospitals in England no case occurred amongst the nursing staff at home. Since the middle of 1906 when the supply of goats' milk to the Hospitals in Malta was stopped the cases amongst the nursing staff there have likewise ceased. These facts are ample evidence of the noninfective nature of the disease from a nursing point of view in contradistinction to such diseases as smallpox etc., and when ordinary sanitary precautions are taken, there is little danger of contagion. But we must not forget the possibility of contracting infection through carelessness in handling the excreta - for instance an infective urine getting into an abrasion or wound of the skin.

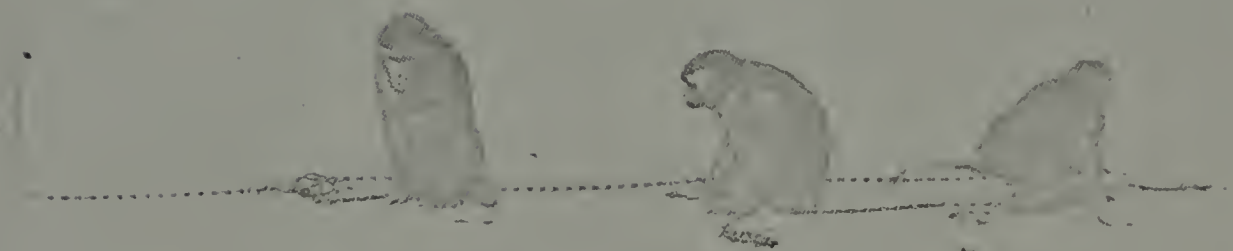
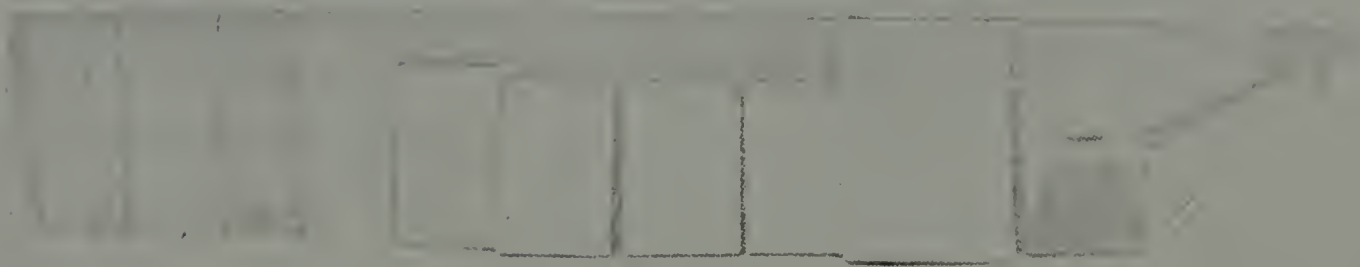
(ii). Sexual Congress:- In the paper just referred to (Journ. R.A.M.C. 4, 1905) I pointed out that of the cases which developed Malta Fever after admission to hospital for some other disease by far the larger proportion were venereal cases. I further collected a series of 124 cases, 20 of which had been under treatment for venereal disease

during some portion of the couple of months before Malta Fever was diagnosed. Of these 20 the probability of the infection being contracted in Hospital could be excluded in 12. (6 gonorrhoea; 1 soft sore; and 5 syphilis). Thereupon I started investigations on these lines and began by going round all the brothels under the escort of the Superintendent of Police. These places were as a rule in an indescribably filthy condition and one would think that it would be possible to contract any disease in existence by patronising these establishments. I collected many bugs, dust, filth and samples of water and submitted all to bacteriological examination, but failed to find any signs of M. Melitensis. With the advent of Dr. Eyre in the summer we started a systematic examination of the Prostitutes themselves. These for the most part are Italians or Sicilians and therefore registered under an Aliens Act which enforces a medical examination three times a month. The agglutination test was applied to 134 of these women and 41 gave a positive result in dilutions varying from 1-10 to 1-200. In only three could we get a history of Fever and one had Rheumatism (?). Of these 41 women 32 were submitted to further examination, viz:- the urine, vaginal swabbings and cervical mucus were examined

for the presence of *M. Melitensis*. In spite of the fact that not more than 3 specimens were examined from any one woman and indeed a third of them were only examined on one occasion, we were able to isolate the micrococcus from the urine of four and from the vaginal swabbings of two, but not at all from the cervical mucus (= mucus swabbed from the os uteri). Of the two women who gave recoveries from the vagina, one was a Maltese and had suffered from an attack of Malta Fever during September to December 1904 - 18 months previously; the other suffered from an attack in January 1906 (5 months previously) soon after her arrival in Malta. Of the two remaining women who provided recoveries from the urine alone, one had been 5 years in the island and could give no history of fever, though the serum agglutinated in 1-50 dilutions: the other also gave a negative history, had been in the island 10 years and agglutinated in 1-100 dilutions.

In this connection also *M. Melitensis* was successfully recovered from the vaginal swabbings and also from the milk and urine of a married woman one week after her discharge as convalescent from the Military Families Hospital, Valletta.

In view of these observations it was necessary to determine whether the micrococcus could gain an



has posts not included
originally.

MS. 9

entrance through the genital mucous membrane (glans penis). It had already been shown that inoculation was possible in monkeys through the uninjured conjunctiva⁽¹⁾ and also in man in Shaw's own case. Unfortunately there was not time to arrange for a natural experiment with animals, therefore the following experiment was carried out⁽²⁾. Two male monkeys were selected and the glans penis carefully examined for scratches or abrasions.

Monkey 203. A strip of cotton wool dipped in fresh urine from an ambulatory case (see bacteriology of urine) was wrapped round the glans and left in contact for half a minute. The wool was then removed and the glans mopped dry with sterile cotton wool.

Monkey 200. Before carrying out exactly the same procedure as in monkey 203 the glans was rubbed with a pad of sterile cotton wool to produce a small area of "friction" excoriation.

The sample of urine used for each monkey was the same and on examination was found to contain 500 colonies of *M. Melitensis* per cubic centimetre.

On the 17th day of the experiment both monkeys gave a serum agglutination in dilution of

(1) Shaw. Reports M.F. Commission V. p. 10

(2) Eyre, McNaught, Kennedy and Zammit. "Bacteriological and Experimental Investigations 1906". Reports M.F.C. VI.

1-20 which gradually rose till on the 28th day monkey 203 agglutinated in 1-150, and monkey 200 1-200. On the 28th day both were killed and the various organs cultured.

Monkey 203 = *M. Melitensis* present in large numbers in right and left inguinal glands and in smaller numbers from the right axillary gland and spleen, but absent from the blood.

Monkey 200 = *M. Melitensis* present in the blood (about 10,000 cocci per cub. centimetre) and also in large numbers from the spleen, the axillary, inguinal and mesenteric glands.

This experiment is therefore interesting as proving the possibility of infection through the genital mucous membrane and the more severe infection of monkey 200 demonstrated at the post-mortem coincided with what one would expect in the presence of a surface lesion.

This investigation therefore clearly demonstrates the possibility of infection by means of sexual congress, and the importance of ambulatory cases and of a prolonged bacteriuria during convalescence.

ii. Indirect Contact. Under this heading I consider the conveyance of infection by means of dried excreta in dust, by flies etc. The considerations that are forced upon us in this connection are:-

(1) 10 to 15 per cent of the labouring population of Malta show signs of recent infection as judged by the serum reaction⁽¹⁾ and 1 to 2 per cent are actually excreting the organism⁽²⁾ while pursuing their ordinary avocations, at the same time paying little attention to the most elementary rules of sanitation.

(2) Thousands of infected goats, dogs and other animals are allowed to roam about the streets making a filthy mess, besides in many instances living under the same roof as their owners (see photo 6).

(3) A frequent premonitory symptom of the disease is inflamed tonsils and sore throat with painful swollen glands in the neck.

These points taken in conjunction with the fact that the dust in Malta in the summer time is excessive all point to the probability that in-

(1) Shaw. "The Ambulatory Type of Case in Malta Fever". Reports M.F. Commission IV. p. 8. and Kennedy. "Maltese Stable Employées" Reports M.F.C. IV. p. 90.

(2) Vide "Clinical Study" - "Bacteriology of Urine" further on.

fection may be contracted in this way. There is, however, little evidence that such is the case in the human subject. And no doubt the sun is a great power for good in the way of sterilising the dust, as one hour's sunlight in the summer time is sufficient to kill off the micrococcus.

Some experiments were made with monkeys by Horrocks and Shaw on infection by means of infected dust, with fair success.

A. Emulsion of Micrococcus mixed with Malta dust was dried and

(a) blown into a closed box to create an artificial dust storm. In the box a monkey was placed. Of two monkeys that underwent one exposure neither contracted infection.

(b) blown up nostrils of monkey. One underwent 15 exposures before infection appeared, another 5 and of two that underwent 1 exposure each one contracted infection.

(c) dropped into conjunctival sac. Of four so treated two became infected.

B. Infected urine (patient's) added to Malta dust blown up monkeys' nostrils. Of four so treated none became infected.

It was during the carrying out of these experiments that one of our laboratory hands contracted the disease. One of the monkeys had be-

come very knowing and learnt to shut his nostrils when the dust was being blown in by means of a rubber bag. One day the attendant instead of using the rubber squirt put his mouth to the tube intending to blow it in himself. Unfortunately for him the monkey blew first! A fortnight to three weeks later he was sent to hospital with an attack of fever. Whether the infection was really contracted by him in this way can not be absolutely decided, but he himself blames the dust.

(3) Milk and its products.

It has been proved by many experiments that it is very easy to infect animals by administering to them milk artificially or naturally infected with *M. Melitensis*. The following is a summary of the first series of feeding experiments on monkeys⁽¹⁾

Table 3.

Source of <i>M. Melitensis</i>	Method of Adminis- tration.	No. of monkeys	
		fed	infected.
Human spleen	i. Culture mashed with boiled potato	2	1
	ii. Culture smeared on potato.	2	2
Human urine.	i. Culture smeared on potato	2	1
	ii. Naturally infected human urine. (a) spread on potato.	3	0
	(b) mixed with dust dried and sprinkled on food.	3	1
	(c) mixed with dust dried and mashed with potato.	3	2
Goats' milk.	i. Culture in emulsion.	1	1
	ii. Culture mashed with potato.	4	4
	iii. Mixed milk from infected herd of goats	4	4

(1) by Horrocks, Shaw and Kennedy.

These experiments were conducted without special reference to amount of infective material administered, and as the administration was conducted over periods lasting from a few days to some weeks no accurate estimate of the incubation period could be arrived at. A further series of experiments were therefore carried out, special attention being paid to these points.

In the experiments summarised below, the infected milk was administered to the monkeys in open pannikins containing 250 cc. of milk at 9 a.m. and at 11 a.m. (two doses) of the same day. The monkeys did not take well to this liquid diet but by means of a little judicious starving and by educating them to drink beforehand they were made to take a sufficient quantity. It was estimated that about 50 cc. of milk was on the average ingested by each monkey. No further doses were given and the blood serum was examined every other day for the appearance of agglutination.

It will be noticed that the first three series of experiments were made with naturally infected milk reinforced by the addition of a milk culture, series IV and V with naturally infected milk alone.

Table IV.

Series of Expts.	Source of Infected Milk	Strength of M. Malignus in Milk (Dose = 50 cc.)	No. of Montages fed.	No. of Montages of course of experiment	Average of days of infection
I	Naturally infected milk obtained by collection of 1 quart slope M. M. derived from milk, to 2 gallons of milk.	11,000,000,000 M. Malignus per cc. milk.	8	8	{ 1 : 15 days 3 : 12 " 3 : 15 " 1 : 20 "
II	"	"	8	7	{ 1 : 12 " 4 : 15 " 2 : 20 "
III	"	"	6	5	{ 1 : 10 " 1 : 12 " 1 : 15 " 2 : 20 "
Total.			22	20	{ 2 : 15 days 5 : 12 " 8 : 15 " 5 : 20 "
IV	Naturally infected milk from two separate goats.	800 M. Malignus per cc.	1	1	: 14 days
		300 M. Malignus per cc.	1	1	: 21 "
V	Mixed milk from healthy and infected goats.	100 M. Malignus per cc.	4	3	{ 1 : 17 " 1 : 18 " 1 : 21 "

In all these experiments the infection of the animals was proved by post mortem bacteriological examination or by the recovery of the micrococcus from the blood during life. Clinical symptoms were for the most part entirely absent and only in a small number was a decided rise of temperature noted. Control experiments were always performed with the same samples of milk sterilised.

These experiments therefore demonstrate in a striking way the infective nature of the milk, and bring out clearly the incubation period.

It was now argued that infection might have gained entrance through abrasions in the buccal mucous membrane and throat, and a further experiment was tried as to the effect of putting the milk directly into the stomach. The results seemed to support the argument.

Forty-five cub. centimetres of naturally infected milk was passed direct into the stomachs of two monkeys through a soft catheter while the animals were under the influence of an anaesthetic. Neither monkey contracted infection.

The influence of Gastric Juice on the organism was investigated in this connection. In the first place the lethal action of Hydrochloric acid on a pure emulsion of *M. Melitensis* was found to depend on the strength of the emulsion - the

stronger the emulsion the more H.Cl. required. Using an emulsion containing 2,000,000 cocci and adding an equal portion of 1 per cent H.Cl. the cocci were killed out in 60 minutes but not in 45. When the strength of the H.Cl. added was 0.1 per cent. the cocci showed signs of decreasing in numbers only at the end of 2 hours. I then tested the effect of an artificial gastric juice made up as follows:- Pepsin = .32 grammes, H.Cl. = .02 grammes. NaCl. = .22 grammes, sterile distilled water = 100 cc. Equal quantities of this and a known naturally infected milk were mixed in a flask and a control made with the same milk mixed with an equal quantity of normal salt solution. The flasks were placed in the incubator at 37°C. and at set intervals measured samples from the flasks were spread on culture plates which were then incubated for 4 days and the resulting colonies counted. The results tended to show that beyond an inhibitory action on growth there is not much lethal action, and in one experiment I was able to isolate the organism from the mixture which had by this time become very acid (tested in the cold = + 84 Eyre's scale) after three days.

The following table shows the result of one experiment.

Table 5.

	<i>Immediate.</i>	Time of Contact.			
		Minutes.			
		15	30	60	2 hours.
25 cc. artificial gastric juice + 25 cc. milk goat 115.	54	64.	13.	25.	44.
25 cc. Normal Saline + 25 cc. milk goat 115 (Control)	56	85	270	189	305

figures = No. of M. Melitensis per measured sample.

It will be noticed that in the first hour there is an apparent diminution. This is probably due to the cocci being held up in the clot; at the end of two hours there is practically no difference in the digested milk, whereas the control milk shows a steady rise in numbers of M. Melitensis.

More convincing proof as to the infective nature of milk containing M. Melitensis for man is hardly necessary than the foregoing animal experiments, but we were favoured with an experiment on the human subject, involuntary it is true, but which could not have been better planned had it been intentional.

In the summer of 1905 an American gentleman

of the Bureau of Animal Industry U.S.A. came to Malta to purchase goats to import to America. In spite of warning he bought a herd of 65 goats and shipped them on the s.s. "Joshua Nicholson" for Antwerp en route for America, on August the 19th 1905. On December the 4th two samples of blood were brought to ^{me} (at Malta) to confirm as to the agglutination reaction to M. Melitensis, and on enquiry I found that they belonged to the Captain and the First Mate of the above named ship. I immediately instituted enquiries and communicated with Col. Bruce⁽¹⁾ who at the same time received communications from Drs. Armand Ruffer and Gotschlich of Egypt⁽²⁾ on the same subject. Subsequently the whole particulars were carefully investigated and reported on by Staff Surg. Clayton R.N.⁽³⁾ who came to Malta in the summer of 1906 as member of the M.F. Commission for Naval Epidemiology.

The herd numbered 65 (61 milch goats) and were shipped on board the "Joshua Nicholson" which called at Malta for a few hours, on August the 19th 1905. The American gentleman and three Maltese

(1) Kennedy. Correspondence to Journal R.A.M.C. January 1906.

(2) Ruffer, Gotschlich, " " "

(3) Clayton. Naval Epidemiology 1906. Reports M.F.Com. pp. 107-120..

goatherds accompanied them. The ship arrived at Antwerp on September the 2nd; here the goats were landed, placed in quarantine, and after five days re-shipped on board the s.s. "St. Andrew" for New York where they arrived about September the 22nd. Here again they were placed in quarantine and as the result of representations made to the Sanitary Authorities by Colonel Bruce, were examined in the early part of October. The urine, blood, and milk of 60 (5 having died) were examined. Fourteen gave a well marked serum reaction with M. Melitensis, 18 more an incomplete reaction and 28 none. The organism was isolated from the milk of two on November 27th and subsequently from several more. All have been kept in quarantine and the infected ones killed off from time to time. At the time Clayton wrote his report 35 of the original and 40 kids of various ages remained in quarantine at the Government Experimental Station at Bethesda.Md.

On the "Joshua Nicholson" the goats were accommodated in pens on deck and their total daily output of milk was said to be about 30 gallons, which diminished somewhat as they neared Antwerp. There were 23 officers and men on board during this trip and most of them drank freely of the milk. Eleven of the crew left the ship at

Antwerp and the after history of eight of these is unknown, but the other three are said by the Captain to have been later under treatment in hospital with symptoms similar to his own. Of the twelve left on board eight developed symptoms of illness, and that this illness was Malta Fever was verified by the agglutination reaction obtained in five. Of the four who developed no symptoms two drank very little as the milk disagreed with them (constipation), and two others (engineers) stated that they always boiled the milk. The itinerary of the ship after leaving Antwerp on the 20th September, with the above mentioned twelve on board is as follows:-

London Sept. 22nd to Oct. 1st.
 Gibraltar Oct. 9th
 Malta Oct. 15th
 Alexandria Oct. 21st to 27th
 Odessa Nov. 3rd to 28th
 Constantinople Nov. 30th
 Malta Dec. 4th
 Antwerp Dec. 17th to Jan. 1st 1906.

The histories of the eight who fell sick is briefly as follows:-

- (1) Captain - first fell ill Aug. 31st, but able to carry on till Nov. 30th when he consulted a doctor at Constantinople. On Dec. 4th diagnosis was made at Malta - agglutination positive, was very ill in January 1906. Incubation period not more than 12 days.

(2) Chief Engineer - illness dated from Sept. 19th - had to consult doctor while in London - able to rejoin ship. Serum reaction positive. Incubation period 18 to 31 days.

(3) First Mate - able to carry on his work till Dec. 4th when serum reacted in Malta, had subsequent "rheumatic" pains necessitating treatment in January 1906.

(4) Steward - illness dates from Sept. 19th, able to carry on work till arrival in Alexandria on Oct. 21st when he was so ill that he had to be sent to Hospital. Serum reaction positive. Incubation period 18 to 31 days.

(5) The Cook - fell ill after leaving London but able to carry on work till arrival back at Antwerp (Dec. 17th) when being crippled with "rheumatism" he was obliged to leave the ship. Serum so far as known not tested.

(6) S -, Able seaman⁽¹⁾ - onset of illness Sept. 22nd sent to Dreadnought Hospital on Sept. 29th. Serum reacted positively. Incubation period 21 to 34 days.

(7) J -, Able seaman - complaining of illness all the voyage, left the ship at Antwerp Dec. 17th. No record of blood examination.

(8) Donkey man - a mild case - blood not examined - but corresponding in particulars to No. 2, the

(1) Vide Editorial. R.A.M.C. Journal February 1906.

Chief Engineer, who, when in London, gave him some of his own medicine.

In Antwerp - Many persons, it is stated, drank the milk both boiled and unboiled but no cases of fever could be traced.

On board the "St. Andrew" though many drank the milk no cases could be traced.

In America. Only two persons were said to have drunk the milk in any quantity, -

(a) the American gentleman who accompanied the goats from Malta died suddenly with what was diagnosed bilateral pneumonia following influenza. No post mortem or bacteriological examination was made however, and the Captain of the "Joshua Nicholson" states that he was "sickening for something" about the same time as he himself.

(b) a female, who drank the milk of several goats for some considerable time, contracted Malta Fever diagnosed clinically and by serum reaction.

Staff Surgeon Clayton goes fully into the epidemiological aspects and is able conclusively to exclude the probability of any other source of infection beyond that of milk.

The non-occurrence of any case (that could be traced) in Antwerp or on board the "St. Andrew" is difficult to explain, but it has already been pointed out how irregular is the excretion of the

M. Melitensis in the milk, and it had probably reached a low ebb by the time Antwerp was reached; further evidence in this direction is afforded by the fact that at first ^{in America} the organism could be isolated from only two of the milks.

To summarise -

Of 60 goats landed in America, 25 were so infected with M. Melitensis that they had to be destroyed. (41 per cent.)

The milk of these goats was drunk by the crew of the "Joshua Nicholson" from Aug. 19th to September 2nd.

Twelve of the crew remained on board for the next trip and of these 8 developed illness of a similar nature, proved to be Malta Fever by the serum reaction of 5. Of the 4 who did not fall sick, 2 boiled the milk before use and 2 had drunk very little.

The incubation period in those (4) whose onset was fairly definite varied from 12 days in the shortest case to a period between 21 and 34 days in the longest.

A woman who drank the milk of these goats in America developed Malta Fever - diagnosed from the clinical symptoms and the serum reaction.

It would hardly be possible to imagine a more conclusive and convincing experiment and no more

need be said at this point as to this mode of infection.

Further proofs of the importance of milk infection will be dealt with under Epidemiology.

PART II.

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THE INCUBATION PERIOD.

The Incubation ranges between wide periods, varying from 5 days to two months or even longer. In a series of cases which became accidentally inoculated in the laboratory the periods were:- 5, 6, 8, 15 and 16 days respectively. At the other extreme are those cases which have been outside the endemic area for two months or more before reporting sick. These are not at all uncommon and are a frequent diagnostic puzzle to medical men at home. In these cases however one can usually elicit a history of the patient having been out of sorts for a month or more before seeking medical advice.

The usual incubation period is from eight to twenty days and the average about ten days. The incubation in monkeys has been carefully worked out with the following result:-

Subcutaneous inoculation - the temperature begins to rise on the third day and serum reacts on the 5th or 6th day after inoculation.

Feeding with infected milk - 25 monkeys fed for one day with infected milk developed a serum reaction in the following order, - 2 on the 10th, 5 on the 12th, 8 on the 15th, 2 on the 17th, 1 on the 18th, 5 on the 20th and 1 on the 21st day, giving an average of 15 to 16 days. The temperature

and symptoms of monkeys infected through the alimentary tract are variable and as a rule so inappreciable that one has to judge the incubation by the appearance of the serum reaction, and due allowance must be made for a delay of two to three days. A monkey bitten by an infected mosquito developed a serum reaction on the 11th day.

PREMONITORY SYMPTOMS.

The symptoms presented by patients first reporting sick are very varied but may be divided into general and local.

The General Symptoms are those of a feeling of general malaise, headache, giddiness, loss of appetite, constipation, bad taste in the mouth in the morning, restlessness at night. Headache is a marked symptom and is usually frontal, extending to the back and down the neck, it may be very severe. Occasional creepy feelings down the back like cold water running down, accompanied by goose skin, and slight rigors. Pain in the back, limbs and joints may be very severe during the first 2 to 4 days of fever. Pain in the epigastrium and a furred tongue. A sore throat with inflamed tonsils and tender glands at the root of the neck is common. Epistaxis is not uncommon. Frequently the patient presents himself in an extreme state of debility and anaemia with the story that he has felt out of sorts for the last month or more. He will have a chronic low fever, foul tongue, mouth and breath, a harsh dry cough and a flabby pulse, he may also have one or several of the local "Rheumatic" symptoms or an orchitis. Such an insidious onset is frequent among women. They lead a sedentary life in the hot weather, begin to feel unwell and

lose the appetite, and then get pain in the epigastric region. This is all attributed to the heat and to indigestion, and when they report sick their chief complaint is of a pain in the left hypochondriac region due to an enlarged spleen. Besides the above symptoms they may complain of thirst, of fainting attacks, and perhaps dysmenorrhoea or amenorrhoea.

Local Symptoms may be the first to be noted such as:- orchitis, which is apt to be mistaken for a venereal affection; lumbago, which may be of an excruciating character; "rheumatic" pains in various parts of the body; swellings of joints, especially the ankle, the wrist, and the small joints of the metacarpal and metatarsal bones, these are sometimes fleeting and fly from one joint to another.

General Description of an Ordinary Case

(Undulant Type).

On admission the patient complains of severe headache and pain in the small of the back, and one or more of the symptoms described under premonitory symptoms. He perhaps feels sick and has vomited in the morning, he aches all over, the bowels are constipated or loose, in any case there is usually a history of irregularity of the bowels. On examination: The Temperature is 102°F or 103°

in the evening and the same or a shade lower next morning. The tongue is furred and dry, there is tenderness over the epigastrium and perhaps also in the iliac fossae and gurgling when there is diarrhoea. The countenance is flushed and the skin dry. There may be harsh breathing at the base of the lungs or even some patches of broncho-pneumonia. The heart sounds are normal and the pulse generally inclined to be slower than one would expect from the temperature.

The urine is scanty and high coloured with deposits of urates on standing or there may be a good deal of bladder irritation with frequent micturition and an increase in the quantity of urine passed during the night.

In a day or two the temperature reaches 104° or 105°F ; any lung complication tends to become aggravated, but it is not in this early stage that lung complications are to be feared. The temperature remains at its height for a varying time with slight morning remissions, but during this period the morning remissions may be absent. About the 5th to 10th day the spleen becomes palpable or at least can be made out to be enlarged. Pain over the spleen is a common complaint. The liver also gets slightly enlarged.

According to the severity of the fever and

its duration so will the patient's condition vary. If the fever remains consistently high during the second week and into the third the tongue gets dry and cracked and the mouth and teeth covered with sordes. The pulse becomes rapid (120-130) and compressible and the heart shows signs of failing. This is the time that lung complications are to be dreaded. Consequent on the enfeebled state of the circulation the lungs become engorged and a hypostatic pneumonia results. Broncho-pneumonia is common and lobar pneumonia may also occur.

During the height of the fever, delirium is frequent, more often it is of the mild rambling type with a few hallucinations, but in the very severe cases may be violent. There seems to be some connection between delirium and epistaxis - a profuse epistaxis appears to relieve the cerebral congestion. In this stage diarrhoea is almost the rule, the stools being very offensive.

During the second or third week (in severe cases it may be the third or fourth) the fever begins to abate and take on a remittent character. The morning temperature remits more and more each day and profuse diaphoresis sets in. In this manner the fever steadily falls and the temperature reaches the normal line, "pari passu" there is improvement in the general condition. The congestion of the lungs is relieved and the cough

gets stronger; the tongue becomes moist and the appetite demands attention, and the patient takes interest in life again.

The apyrexial period follows but is a very variable quantity. It may last for a day or two or for two weeks and the patient may have so far recovered as to be able to get up. During this period he may complain of some pain in his larger joints or down the sciatic nerve.

The Relapse (or "second wave") is usually heralded by a sensation of cold water running down the spine or by a rigor or a headache, and a slight rise of temp. is noted. Then comes a gradual ladder like rise of temp. to 103° or 104° , rarely 105° , at the rate of about 1°F. a day. The height is not so sustained as in the 1st attack, and the fall is more gradual than the rise. During this second "wave" the patient does not seem much inconvenienced in ordinary uncomplicated cases. He will probably have some headache and lose his appetite and may suffer from constipation or diarrhoea. This second "wave" does not as a rule last so long as the first, nor is it so severe, but it may cause grave danger from an access of pulmonary congestion or from cardiac failure, either of which may be consequent on debility and a too short apyrexial period.

The second apyrexial period is longer than the first and the patient begins to get on his feet again, but now the local symptoms have their innings. These begin as flitting pains in the ankle joints or between the ankles and knees or between the elbow and shoulder. Then the larger joints get affected and effusions may occur, especially in the hip, knees, ankles and shoulder; the bursae, especially the elbow and the deltoid are favourite seats for effusions, so also are the sterno clavicular and the costochondral articulations. Perineuritis especially of the sciatic nerve occurs in the majority of cases. The patient is often rendered quite helpless by these sequelae. It may be interesting to give the writer's own experience of these sequelae.

On the 70th day of disease the temperature had reached normal after the second "wave", and pain in the left shoulder set in. On the 89th day the bursa over the tip of the right olecranon became inflamed and swollen. On the 94th day the bursa over the left ischial tuberosity, on the 101st day the bursa over the left olecranon and the joints - metacarpal-phalangeal and 1st phalangeal - of the little finger; on the 110th day acute synovitis of the left ankle and epidydimitis of the left side set in, and on the

114th day acute synovitis of the right ankle.

These various local manifestations persisted with varying degrees of intensity for three months, the ankle joints were the most intractable.

Before the patient becomes convalescent there may be more "waves" or relapses; it is common enough to have five (four relapses) but the usual number is three (two relapses).

The third wave (second relapse) usually occurs about the end of the second month and tends to be less severe and of shorter duration than the preceding. A relapse has a curious effect on the local (arthritic and neuritic) symptoms and causes an alleviation of the pain; this has also been noted by Hughes, who says - "there would appear to be a relation between the amount of fever and the severity of the pain in an inverse proportion". The third wave over, the pains return again and gradually wear themselves out following the fashion of the fever.

Sometimes the local affection takes on an acute character e.g. acute orchitis, and causes a rise of temperature; this may be very high (104°F) rising suddenly and falling as rapidly, but does not partake of the nature of a true "wave".

The general condition of the patient when convalescing is that of anaemia and debility,

which is as a rule easily treated by nourishing food and tonics, but sometimes a condition of severe anaemia with scorbutic symptoms results or the fever may become chronic.

CLINICAL TYPES.

In a broad general way the cases may be classified as follows:-

- I. Malignant Type - usually fatal in three weeks.
- II. Severe fever of undulant regular type with mild local symptoms.
- III. Mild fever of chronic remittent or irregular type with very severe arthritic and neuritic symptoms.
- IV. Mild regular fever with no sequelae.

As a matter of fact most of the cases may be classified under these headings, but for the present purpose I shall classify according to the Fever as being the most distinctive feature:-

<u>Class.</u>	<u>Type.</u>	<u>Local symptoms and sequelae.</u>
I.	Malignant	fatal. usually in 3 weeks.
II.	Undulant	
	(a) severe	moderately severe or mild.
	(b) mild	mild.
III.	Chronic	
	(a) Remittent	} usually very severe.
	(b) Irregular	
IV.	Other Irregular Types.	varied.
V.	Aborted.	nil.

Class I. In this class are those cases in which the specific infection is so virulent as to cause the death of the patient. The onset is rapid and the patient reports sick on the 2nd to the 5th day. The temperature reaches its highest point (usually 104° - 105° F) about the 10th or 11th day; thereafter, though it may show a tendency to drop two degrees, it remains persistently high between 103° and 105° without any marked morning remission. About the 15th to the 17th day it again tends to rise and death supervenes about the 21st day. Just before death the temp. runs up very high. Charts 5,6,7,8 are good examples. In these cases cerebral symptoms are marked. There is slight retraction of the head, muscular twitching, sleeplessness, acute delirium of a noisy and sometimes violent character, involuntary micturition and defaecation and finally unconsciousness \ coma and death from heart failure.

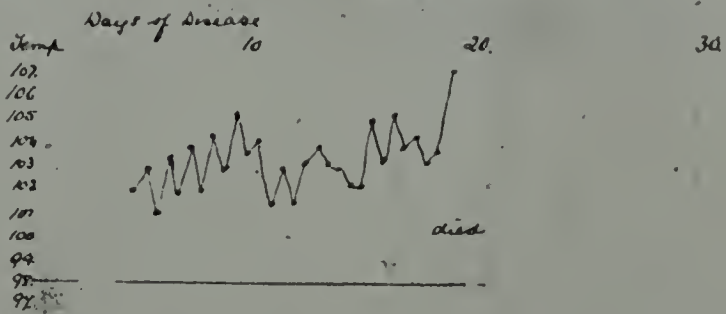
Class II. (a) Severe Undulant. This is the classical type and the general description given (p. 13) above, will suffice. Charts 9,10,11 are typical.

(b) Mild Undulant. Under this heading I place those cases with mild typical fever and little or no local symptoms. Such cases are illustrated by Charts 12,13 and 14.

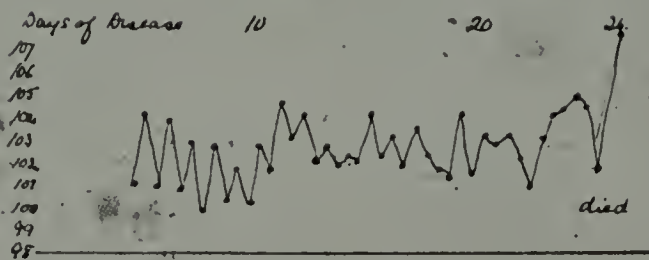
Charts 5, 6, 7, 8

Illustrating Class I. Malignant Type.

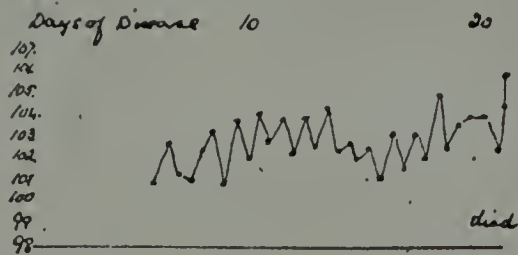
V.



VI.



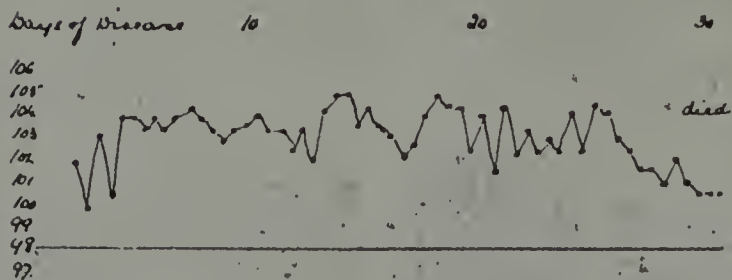
VII.



Urine examined 0 0 0 0 0 2

M. M. obtained from
urine in bladder
at post-mortem

VIII.



*Illustrating Class II (a)
Severe. Undulant Type.*

ing disease.

Chart 9.

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Line examined
by Jones M.M.

Chart 10.

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Line examined
by Jones M.M.

Chart 11.

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2
1
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Line examined
by Jones M.M.

+ Colonies absolutely innumerable
any number between 500 to 800 in each drop of urine.

Charts 12, 13, 14.

Illustrating Class II. (6).

Mild Undulant Type.

Days of Disease

10

20

30

40

50

60

70

80

Chart 12

106
105
104
103
102
101
100
99
98
97

Urine examined

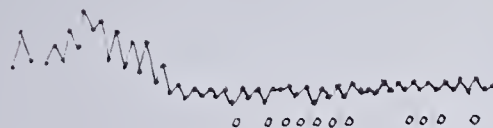


Chart 13.

107
106
105
104
103
102
101
100
99
98
97

Chart 14.

107
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102
101
100
99
98
97

Class III. Chronic.

(a) Chronic Remittent. These may begin in the orthodox way and pass into the chronic remittent, see Chart 15, or they may have the remittent character from the start - see Charts 16 and 17. In the two latter cases the pains were of an excruciating character, the roots of the nerves arising from the lumbar region of the spinal column appeared to be the seat of the irritation. This was evidenced by girdle pains, intestinal neuralgia and colic, lumbago, and acute pain down the nerves of the groin and the thigh.

(b) Chronic Irregular. This variety may also start with the undulant type, see Chart 18. This case was discharged to light duty but was re-admitted after an interval of three months with very severe sciatica and lumbago and a chronic temperature of a type which is more or less remittent but not so marked as Charts 15 to 17.

Chart 19 illustrates a case starting with a low irregular fever with very severe sciatica and effusion into the hip joint.

Class IV. Other Irregular Types.

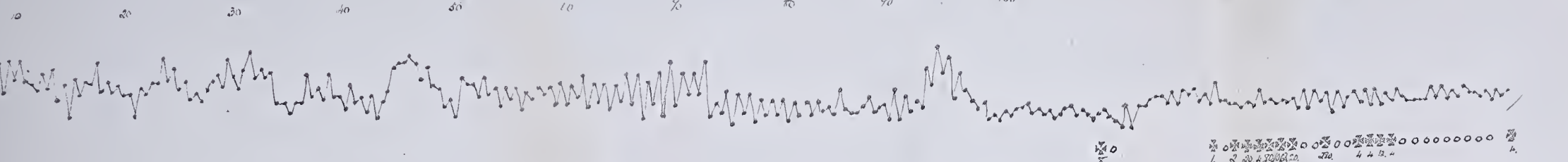
It is almost unnecessary to create a special class for what are merely variations and mixtures of the preceding, but I wish to draw attention to at least two important variations. The first is

Charts 20. 21. 22.

Illustrating Classes IV and V
Other Irregular Types and Abortive Type.

Chart 20.

100
95
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45
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35
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25
20
15
10
5
0



and continued
No. of Series 14.

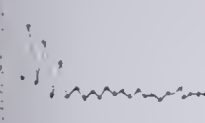
Chart 21.

100
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25
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15
10
5
0



Chart 22.

100
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45
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illustrated by Chart 20, a series of short and severe "waves" following on each other without intermission. It will be noticed that it gradually merges into the remittent type and ends up with mild undulant relapses.

The second is illustrated by Chart 21, which shows how a very mild initial attack may to all appearance have become cured but, after an interval which may be prolonged to two months, relapses again with increased severity. These cases are intermediate to the ordinary class of case and the aborted case.

Class V. The Aborted Type.

This is a class of case which has only recently been recognised. There is an association between cases of slight fever of short duration diagnosed S.C. Fever and Malta Fever. The years in which S.C.F. has been greatest are the years with the largest number of Malta Fever cases, also the proportion of Malta Fever cases which have suffered from S.C.F. within the previous few months is large. There would therefore seem to be a distinct connection between the two, and I am sure that many S.C.F. cases are but aborted Malta Fever. Such a case is illustrated by Chart 22. In this case a distinct agglutination reaction was present, but disappeared in a few

days. This patient returned to Hospital with a definite attack of Malta Fever after six months, during which period he had been quite well.

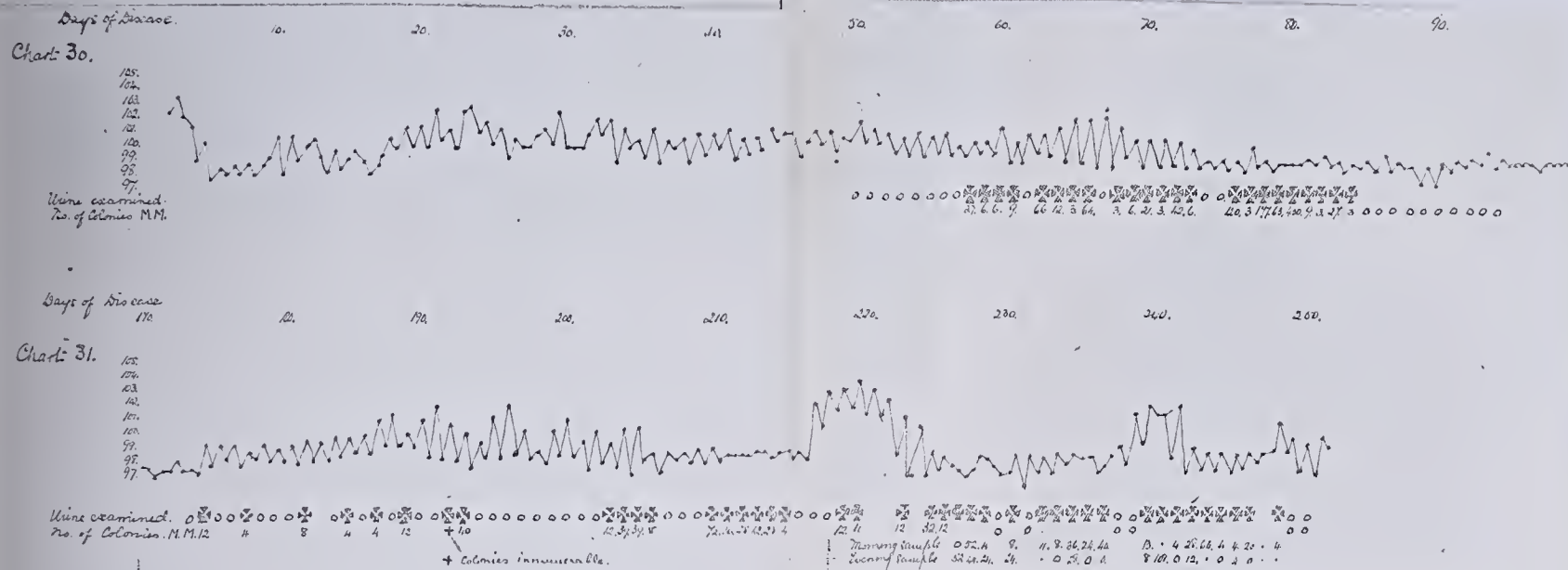
Chart 30. + 31.

To show the excretion of *M. Nechtensis* in the urine and its relation to the temperature.

Chart 30. A moderately severe case - excretion at the end of the fever and extending into convalescence.

Chart 31. The end of a very prolonged case - Note short-finned waves. Excretion marked. See photos 11 & 12 of plates made from urine of 192nd day of disease.

Note examination of morning & evening samples of urine from 227th to 249th days.



SYMPTOMS IN DETAIL AND BY SYSTEMS.

Pyrexia.

The Fever ∴ is a remittent fever generally relapsing several times and sometimes becoming chronic. The relapses give the chart a "wavy" appearance (Undulant Fever - Hughes). The characteristics are best seen in the later stages, the latter "waves" (or relapses) being more typical than the 1st attack unless in very mild cases where there may be only one relapse or none at all, in which the 1st attack is similar to the last waves of a severe case.

Its Duration varies from a week to two years. Some cases recover without a relapse but these are very few - about 1% - and last from 5 to 10 days. About 10% get rid of the fever in 30 days. from 40 to 50% " " " " 60 " in about 20% the fever lasts over 90 days. and in " 5% " " " " 120 "

The duration of the first attack is very variable, but on the average is from 10 to 20 days. It may be as short as 5 and as long as 69 days. In mild cases the temp. falls at the end of a week and even long and severe cases show a tendency to fall at this period. This has also been noted in Enteric.

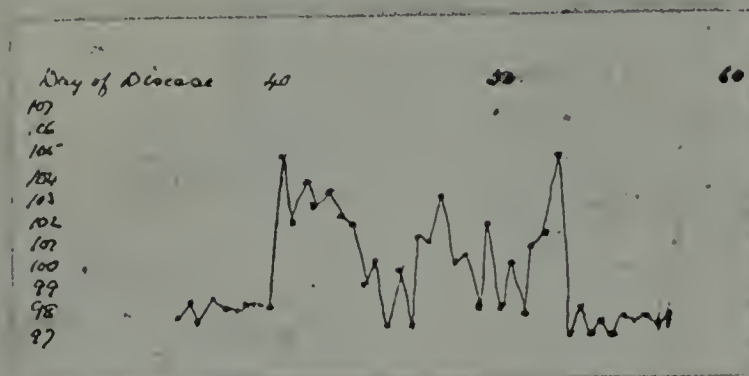
The first apyrexial period in a typical case

lasts from 1 to 5 days but the 1st relapse may be delayed for a month.

The first relapse (2nd wave) is as a rule the most characteristic, with a steady ladder like rise for 3 to 6 days, and a more gradual and regular fall to normal. (see Chart 21).

The character of the final relapses is well illustrated in Chart 10, and it is interesting to note how a case which has been prolonged and perhaps irregular in its type of fever will end up with a typical "wave", see Chart 16. A curious exaggeration of a final wave is illustrated in the following chart:

Chart 23.



Diurnal Variation. In acute cases the highest temperature is recorded from 6 to 8 p.m. and the lowest from 8 to 10 a.m. The temp. begins to rise about midday and the greatest temperature is recorded sooner or later after this time according as the disease is in an acute stage or nearing its final stage; for example - as the end of a wave is approaching, the highest recorded temp. for each day is earlier than that of the

previous day. The variations between morning and evening temp. may be great, viz. chart 23, also Charts 15, 16, 17.

Hyperpyrexia:- The temperature rarely reaches 106 F. but 104° and 105°F are common and almost the rule. The highest temp. is usually experienced in the 1st attack and generally occurs within the 1st week. The cases of the malignant type and with cerebral symptoms are those where hyperpyrexia is prolonged and resistant to treatment. In some cases sudden hyperpyrexia is associated with epileptiform seizures, when the temp. may run up to 107°F. Before death in malignant cases the temperature may run up to 109°.

Alimentary System.

The tongue at the beginning is furred and presents a flabby appearance, the edges and the tip are often red; later on it gets dry and glazed and caked with sordes. The whole mouth is apt to get very foul and the lips and teeth covered with sordes, in long standing cases with scorbutic symptoms bleeding from the lips and gums may occur.

The secretions of the mouth get dried up and the salivary glands (especially the parotid) may become inflamed. Acute Parotitis occurred three times in one case, appearing first on the right side on the 12th day, then on the left on the 15th

day and again on the left on the 46th day. The swelling, which is very painful, may appear quite suddenly and disappear just as quickly, the whole attack being over in 24 to 48 hours. In one case abscess resulted and in another the submaxillary was the seat of an abscess. The Tonsils are in a large number of cases red and swollen and the glands of the neck enlarged and tender. This is one of the earliest symptoms.

The appetite in the premonitory stage is capricious and of course in the height of the fever practically destroyed, but as the fever abates and the tongue clears up and becomes moist so does the appetite return. It is a curious fact that during the later relapses the appetite may not suffer and the indulging of it with light food such as fish, chicken, milk puddings, would not appear to have any bad effects as long as the digestion is not disturbed.

On the other hand the digestion may get so disordered that even during convalescence it will have to be humoured with such things as peptonised food, arrowroot and prepared foods. This condition of atony of the stomach and intestines may be accompanied by a voracious appetite, which makes it the more trying to treat. Thirst is not a very marked symptom until the sweating stage

comes on.

Vomiting is not uncommon but is usually aggravated by a complication, viz. Alcoholism, Malaria or Neurosis; it may be very persistent, very difficult to treat, and cause anxiety.

Abdomen:- There is usually some abdominal pain in the first stages which is referred to the epigastrium, where there may be tenderness on pressure, it is rarely referred to the iliac fossae. Later on perisplenitis (see spleen) may cause severe pain of a transient or more persistent character.

A marked feature, especially in prolonged cases, is the wasting and loss of tone which the intestines undergo; in consequence tympanitis is almost sure to be a marked symptom unless precautions are taken. This should be specially guarded against when any lung complications are present. Severe colic may be a marked symptom in cases where the spinal cord would appear to be affected (see nervous symptoms).

Constipation is the rule in convalescence, due no doubt to the wasting of the muscular coats of the intestines.

Diarrhoea is common in the very acute stages, and a so-called "typhoid state" may supervene with involuntary liquid stools, resembling Enteric and very offensive.

Haemorrhage from the bowels occurs in a few cases and would appear to be analogous to and is usually accompanied by haemorrhage from the nasal mucous membrane. This haemorrhage is not necessarily associated with intestinal ulcers. (see morbid anatomy). It is a curious fact that haemorrhoids may develop during the course of the disease but generally disappear during convalescence. The liver gets slightly enlarged.

Haemopoietic System.

Lymphatic vessels and glands. All the lymphatic glands are slightly enlarged and those lying in the neck posterior to the sternomastoid muscle become tender very early in the disease. The glands are the last organs in the body for the micrococcus to leave (see morbid anatomy).

Lymphangitis has occurred in one case in both legs with enlargement of the popliteal glands.

Spleen: The enlargement of the spleen is a classical symptom and one that is invariably present when there is systemic infection. The enlargement reaches the costal margin about the 10th day and becomes palpable, in average cases it reaches for two finger breadths below the costal margin, but may reach down to the umbilicus. Care must be taken not to miss an upward enlargement. Perisplenitis is not uncommon and the peritoneal rub may be distinctly palpated.

Blood:- The most noticeable feature is the increase in the nongranular white cells chiefly in the small lymphocytes. This becomes more marked the longer the illness lasts, and especially if scorbutic symptoms set in, when of course anaemia is present.

The following table illustrates the leucocytic count taken at different stages of the disease.

Table 6.

Patient	Day of Disease	Red cells per cub. millimetre.	White cells per cub. millimetre.	Differential count "Leucocytes" per cent.	
				Granular.	Nongranular.
Pte. S -	6	5,800,000	6,094	62	38
Pte. A -	49	4,600,000	9,333	23	76
Pte. M -	197	4.460,000	13,666	19	81
normal.			7,500	71	29

Pte. M - is an example of an extreme case, full particulars of which are given on p.113 under Integumentary System.

The number of red cells usually shows a decrease and the haemoglobin is diminished out of proportion to the number of red cells, the index per cell may fall to 0.5.

That the fluid constituents of the blood undergo changes is evidenced by the serous and haemorrhagic rashes that are frequently present, but I have made no actual observations.

Circulatory System.

The condition of the heart is all important, as the strain of such a continued pyrexia is very great, and the prognosis depends to a very large degree on the condition of this organ (see complications).

Of the conditions arising during the disease the most serious is heart failure, the result of pyrexia and exhaustion. The heart sounds may be almost inaudible and the rhythm altered e.g. galloping rhythm; and the pulse not perceptible at the wrist. Even with such grave symptoms the patient may recover. There is usually dilatation of one or both ventricles and the apex beat may be displaced outwards beyond the nipple line. There may be cardiac pain and irregularity of the heart's action is common. Intermittency of the pulse may be present independently of the heart's action. Intermittency of the heart's action occurs most frequently as a "wave" is subsiding, as if the organ were trying to snatch a rest to recover from its previous over-exertion. A collapsed condition with barely perceptible pulse may occur during the height of the fever early in the illness (see chart 9) before the heart has been seriously debilitated, and is probably due to toxæmia. The pulse gets more rapid as the disease progresses and may attain the rate of 150 per minute. In

those cases to which I drew attention that have an insidious onset and where the patient has been struggling against his sickness, a slow pulse of low tension is the rule and should be regarded as a danger signal.

It is very rare to get peri-or endo-carditis, but they have been described. I have seen one case with endocarditis which had originated during the attack, but not one of my own cases. Murmurs are not uncommon, but clear up in convalescence and are haemic.

Veins:- Phlebitis is not uncommon, and in one case occurred twice on the 54th and 131st days respectively in different legs.

The occurrence of haemorrhoids has been noted above.

Arteries:- In one case shown to me by Col. Bell. R.A.M.C. it was presumed that the abdominal aorta had become occluded as no pulse could be detected in either of the femorals.

Capillaries:- As well as an alteration in the Blood there must be alteration in the walls of the capillaries and small arterioles whereby they are weakened. At least I should imagine so from the fact that bruises arise from the slightest blow and haemorrhages into the subperitoneal connective tissue and intestinal submucosa are frequently noted (see morbid anatomy). In the

writer's own experience this condition of liability to bruises persisted for about six months.

Respiratory System.

Nares:- Epistaxis occurs in the first fortnight in about 5% of cases and is usually easily controlled. It sometimes occurs later on in the disease, may be very profuse and necessitate plugging of the anterior and posterior nares.

Cough may be present without physical signs in the lungs and would appear to be of a nervous origin and have relation to evening rise of temperature.

Lungs:- Congestion of the lungs occurs in about 80% of cases and almost invariably in the severe.

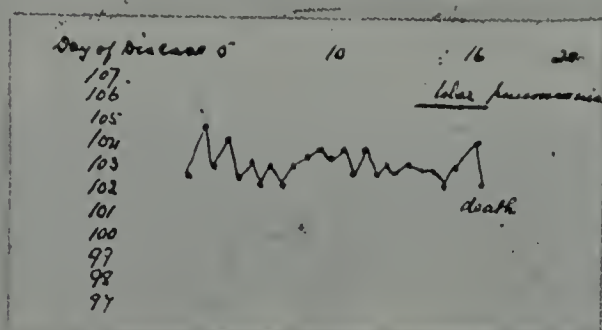
It is of course basal and frequently results in a pneumonic condition. The liability to congestion is of course increased by the presence of organic disease of the heart and old pleuritic adhesions.

Broncho-pneumonia is a frequent accompaniment and may be one of the earliest symptoms. It frequently aggravates the relapses. In one case a septic condition ensued with small bronchiectetic cavities, probably aggravated by old pleuritic adhesions.

A Lobar Pneumonia is not infrequent and is most frequently apical. The following chart illustrates a case in which the whole of the right lung was congested and the superior lobe was in a condition of acute congestion - first stage of lobar

pneumonia.

Chart 24.



Pleura:- Pleurisy rarely occurs unless as an accompaniment of the above mentioned lung complications, when it may vary from a pleuritic rub to a considerable effusion. When pleurisy occurs by itself it is usually dry and rarely becomes an effusion. I have never seen an empyema result, but a brother officer has described a case in which the empyema was evacuated and a pure culture of *M. Melitensis* obtained from the pus.

Photo. 9.

To show the emaciation in a severe case.

Integumentary System.

Emaciation when the disease is severe and prolonged is extreme (see photograph 9).

Oedema of the ankles and legs occurs in proportion to the anaemia and debilitated state of the patient. It may be due to kidney complications.

Diaphoresis is one of the features of the disease.

It occurs when the fever is abating, and is in proportion to the remittency of the temperature.

It may be very profuse and necessitate a change of clothing four times a night. During sleep is the most favourable time, and it will be seen to come up in great beads on the forehead, collect in a little pool in the suprasternal notch and trickle in a stream over the sternum and down the flanks. The Sweat contains the toxins of the disease, but not the microbe, as has been proved by the injection into animals (Med. Fever Reports).

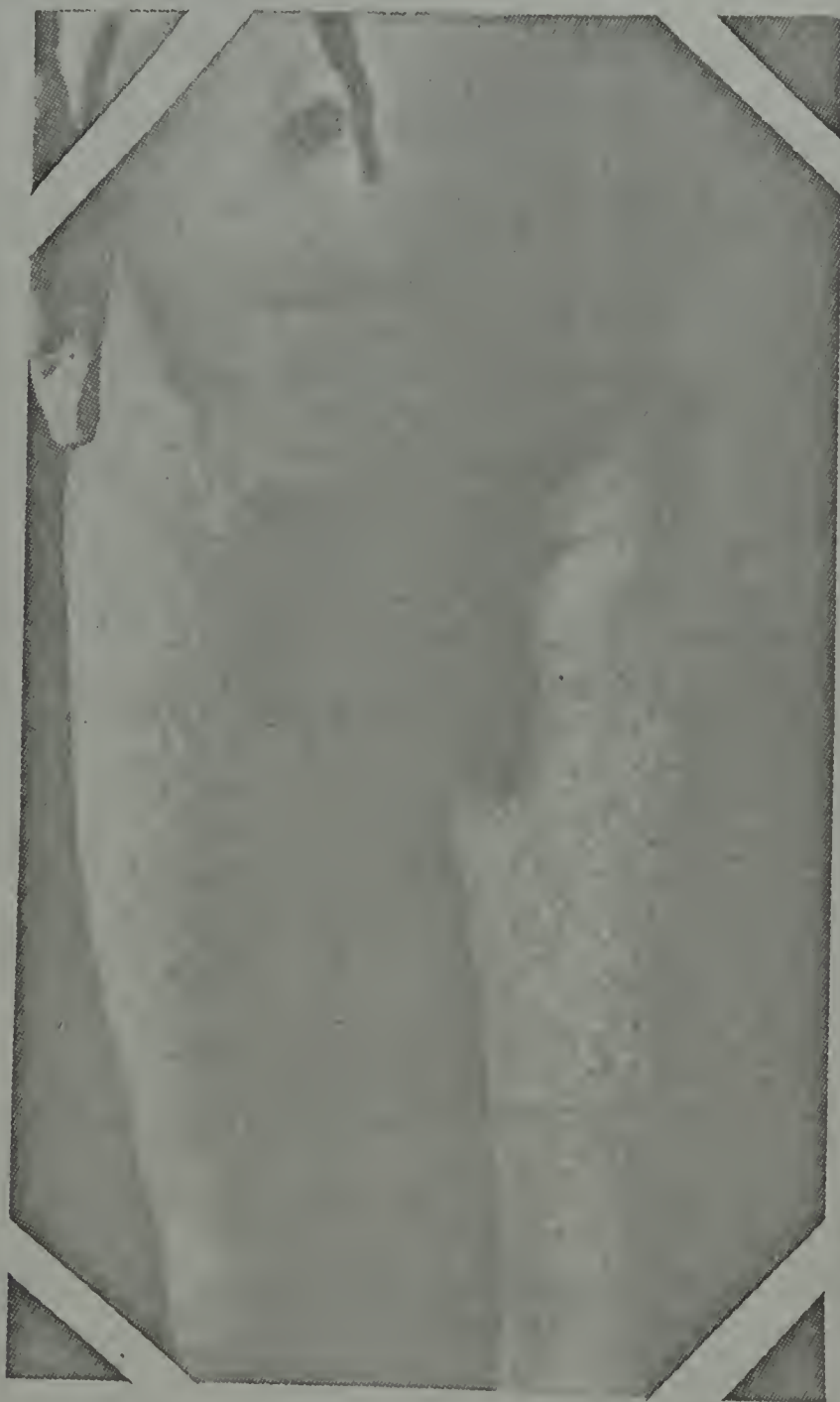
Eruptions:- The skin becomes sodden as the result of such profuse diaphoresis and liable to microbic invasion. Sudamina are common, so are boils, and small abscesses.

Haemorrhagic Eruptions (a) small subcutaneous haemorrhages half the size of a pea and giving a shotty appearance frequently occur in very severe or malignant cases; they become pustular and burst through the skin, leaving a deep circular pit as if a shot had become embedded and then removed.

(b) small red spots frequently occur on the flanks and abdomen. (c) Purpuric rashes on the thighs and legs occurred twice in one case of which a photo is given (Photo 10). This was a long continued case with scorbutic symptoms and also had very severe urticaria. Intense urticaria occurred in three of my cases, in two cases on the 12th day and in the other (mentioned above) on the 74th day.

The hair suffers from the general debility and falls out, but the damage is rarely permanent.

Photo 10.



Hæmorrhagic Rash
on thighs and
lower part of
abdomen.

Pl. M - Essex Regt. admitted 11th Sept. 04. on 3rd day of illness.

Mild type of fever. 1st 'wave' lasting 14 days, 3 days of
apirexia, 2nd 'wave' mild remittent lasting 8 days, then no
temperature till 51st day. when mild chronic remittent fever
set in till 77th day. another rise on 90th day and again on
95th till 99th day. - discharged on 125th day (11 January 1905).
Readmitted on 23rd Jan'y (137th day) with bleeding gums and
another relapse of fever which lasted 5 days. He had two
more mild relapses, and was invalided home in April, 05.
(210 days).

He had recurrent attacks of urticaria which left hæmorrhagic
mottling after the swelling subsided, also bleeding from
the gums and lips.

The condition of the Blood is noted (see 'Blood' Table 6. page 105.)

Urinary System.

Bladder irritation and frequency of micturition - particularly troublesome in the night time - is a common complaint during the incubation and invasion stages. Later on in severe cases retention of urine may occur, especially in neurotic subjects. Cystitis may be present but is usually associated with retention. Disease of the kidneys arising "de novo" in the course of the disease has not been met with in my experience, but an old trouble may be lighted up afresh or as in one of my cases an attack of Malta Fever may supervene on an attack of acute nephritis.

The Urine.

In order to arrive at some idea of the alterations in the urine, I carried out a series of observations on six patients representing the urinary excretion of 129 days. The following plan was followed throughout.

Collection of samples:- On waking in the early morning the patient was made to pass urine into a sterile flask, this was usually about 6 a.m. and the flask was labelled "a.m.". A "p.m." sample was also collected as aseptically as possible in a sterile flask at 6 p.m. All the rest of the twenty-four hours' urine (6 a.m. to 6 a.m.) was collected in a large bottle kept at the bedside; at the end of the twenty-four hours this was

measured, shaken up and a sample taken in a flask labelled "rest". The quantity passed into the Bedside bottle + the "a.m." sample + the "p.m." sample gave the total passed in 24 hours.

Examination of samples:- Each of the "a.m." "p.m." and "rest" samples was examined for - colour, specific gravity, reaction to litmus, total acidity in hot and cold, albumen, sugar, microscopic sediment and presence of *M. Melitensis* by culture. These samples were then mixed together in proportionate quantities and tested for urea, uric acid and chlorides.

Colour:- when the temperature is high and also when there is diaphoresis the colour is dark, resembling sherry.

Quantity:- This varies with the temperature and the amount of diaphoresis, see Charts 25, 26 and 29, in which the quantity is diagrammatically represented and compared with the temperature curve.

Specific Gravity:- A reference to Charts 25, 26 and 29 will show how this is affected and its relation to the temperature and the total quantity excreted. Note the normal variation in normal persons during the hot season in Malta, viz: total quantity about 1260 cc. daily and specific gravity 1023.

In the cases examined

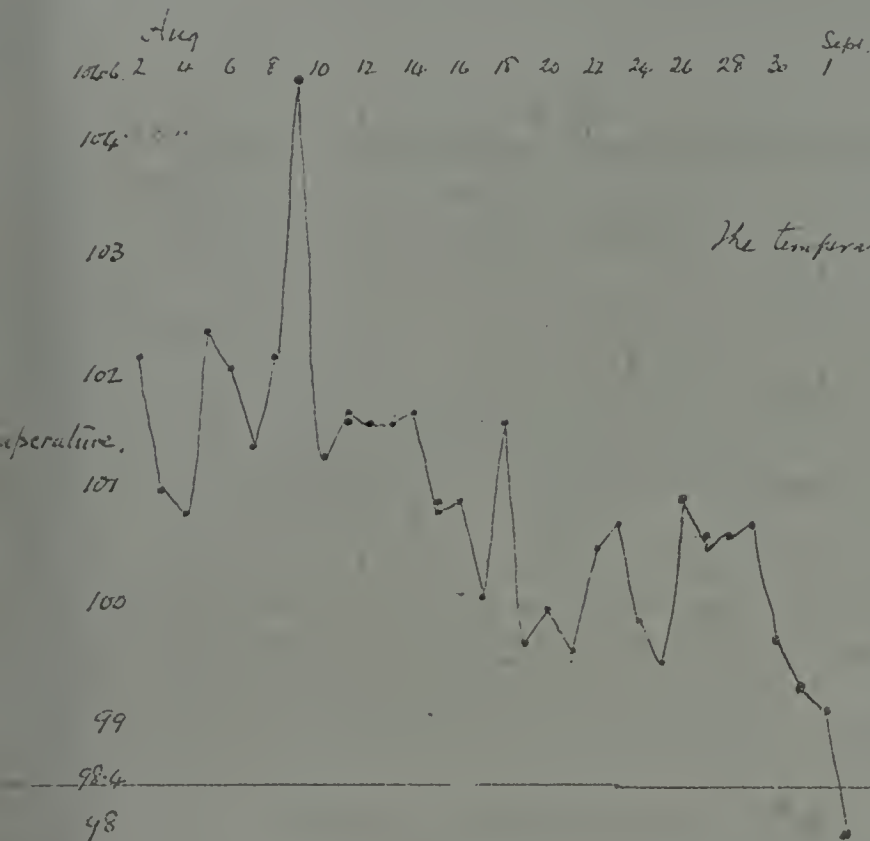
the average sp.gr. of 117 "a.m." samples was 1016.97

Charts 25. 26.

Quantity and Specific Gravity of Urinary Output compared with Temperature in cases of Malaria Fever.

Chart 25.

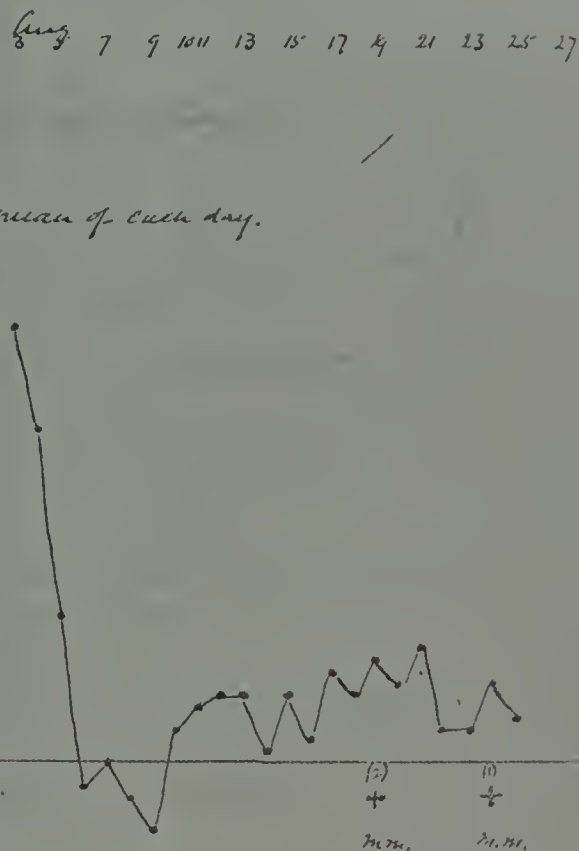
Gen. Langstone R.G.A. adm. 30th VII 06.



The temperature is the mean of each day.

Chart 26.

Gen. Ward R.G.A.



the average sp.gr. of 109 "p.m." samples was 1017.2
 " " " " 129 "rest" " " 1016.56

The lowest density noted was 1002 and in another case 1007, both these were "rest" samples, and the density of the total 24 hours sample was 1010 in each case. It is worthy of note that in each case *M. Melitensis* was being excreted in considerable quantities on these respective days.

Reaction to litmus:- The "a.m." and "p.m." samples being fresh and preserved in sterile plugged flasks *were invariably acid.* *The "rest" samples* were as a rule decomposed, had a heavy sediment, smelt ammoniacal and gave an alkaline reaction.

Total acidity:- This was tested in the cold and at boiling point. The indicator used was phenolphthalein, and the reagent a decinormal solution of sodium hydrate. To the cold was added ammonium oxalate (crystals) to saturation and the difference between the acidity in the cold and at boiling point represented the inorganic acids. The results are given in cc. of normal soda solution which would be required to neutralise 1000 cc. of the sample under consideration.

To obtain a normal standard morning samples from twenty healthy men were tested and found to give the following average result - that the acidity in the cold was represented by 63.72
 and at boiling point by 105.22.
 the difference (representing inorganic acidity) = 41.5.

that is, 40 per cent represents the normal amount of inorganic acidity in the total acidity.

The following table gives the average of all the observations compared with normal.

Table 7.

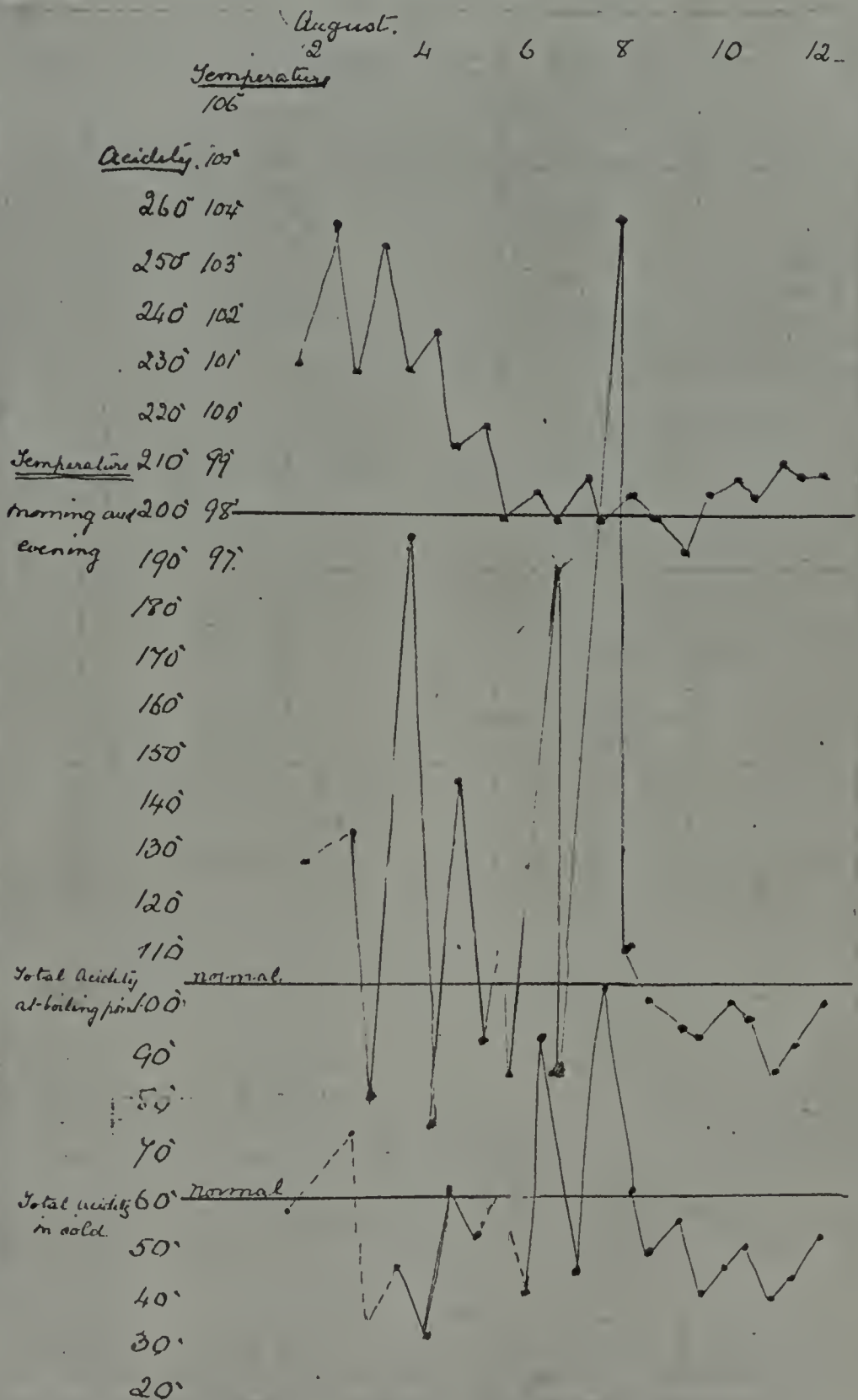
		Malaria Fever Urine.						
	Normal Samples		A.M. Samples		P.M. Samples		Rest Samples	
	No.	Average Acidity	No.	Average Acidity	No.	Average Acidity	No.	Average Acidity
Ac. Boiling Point	20	105.22	118	80.6	111	86.06	126	56.86
In Cold	20	63.72	115	39.3	110	43.28	126	17.1
Difference (Inorganic Acidity)		41.50		41.3		42.78		39.76
% Inorganic to Total Acidity		39.5		51.0		50.4		69.0

These observations point to a considerable reduction of total acidity but that the reduction does not affect the inorganic acidity. The large percentage of inorganic in the "rest" samples may be explained by decomposition.

If a closer examination of the results is made and the daily observations compared with the temperature chart we find what I have diagrammatically represented in Chart 27. This shows an extraordinary variation between the morning and the evening acidity. This is probably explained by the defervescence shown in the chart and the diaphoresis which would occur each night. A further analysis of the above chart shows that the proportion between the hot and cold readings shows little variation, - in other words that the inorganic acidity does not vary much in proportion

Chart 27.

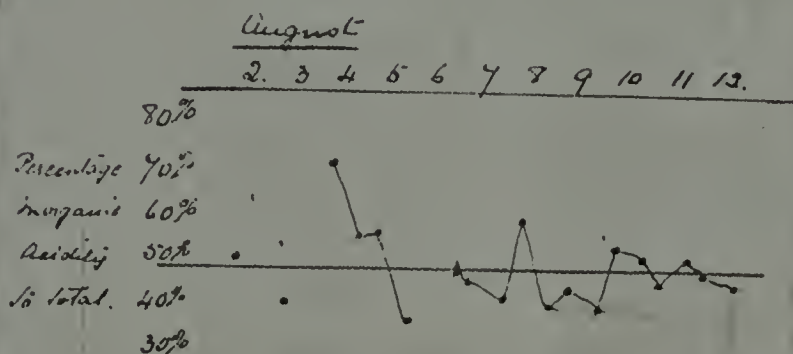
Showing variation in Acidity of Urine during
Defervescence and Diaphoresis.



to the total. The following chart depicts these variations plotted about a line representing the average percentage of inorganic acidity in Malta Fever.

Chart 28.

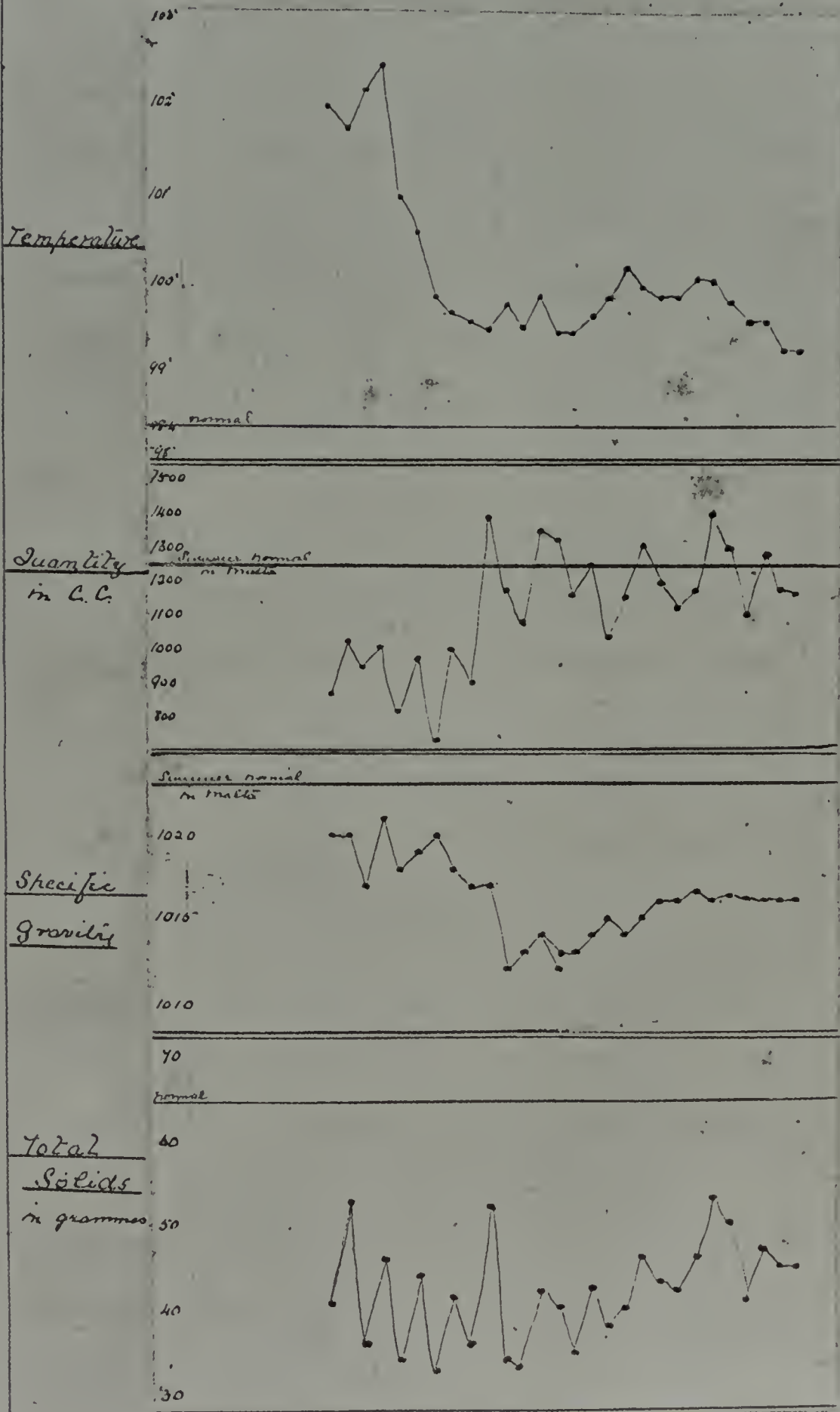
Variation in proportion of Inorganic Acidity to Total Acidity during Defervescence and Diaphoresis.



The elaboration of these observations, which of necessity under the circumstances were more or less crude, may appear laboured, but I think they are of sufficient interest to record, quite apart from the consideration of the labour entailed in making the observations, which numbered considerably over 3000.

Chart 29.

Representing the Average of Series of Observations on four Cases of Malaria Fever, in which the mean daily Temperature and the mean daily quantity, specific gravity and Total Solids of the urine were observed.



Total Solids:- These were calculated from the specific gravity, and were found to be considerably below normal. The accompanying chart (Chart 29) represents the total solids in four cases. The average of the four observations on each day is plotted and the resulting curve compared with the average mean temperature, the quantity and the specific gravity of the same four cases. The text book normal (60 to 70 grammes daily) was found to represent fairly accurately the normal summer excretion of total solids in Malta.

Chlorides:- were found to be slightly diminished and more so during pyrexia.

Phosphates:- were not calculated quantitatively but judging from the observations on inorganic acidity and the dense deposits of phosphates which occurred when the urine turned alkaline their total excretion is not diminished and in proportion to the rest of the solids is increased.

Urea:- This is decreased considerably during defervescence and diaphoresis, and so also is

Uric acid:- crystals of uric acid are readily deposited in samples that are kept in sterile flasks where the urine remains acid.

Albumen is very rare even during high fever. Of course it is present when there are kidney or

bladder complications.

Blood, apart from the above mentioned complications has never been noted.

Sugar has not been noted.

Pus occurs with cystitis.

Ehrlich's Diazo Reaction is said to occur, but only in the early stages. Personally I have no experience of it.

Deposits:- Urine preserved in sterile flasks remains acid for an indefinite period and rarely shows a marked deposit. There is usually some mucus, and it is noted that its presence in some quantity is associated with the presence of the Micrococcus in the urine (see Bacteriology of urine). Crystals of uric acid readily form on the sides of the vessel and crystals of oxalates are usually present. Amorphous urates are also common. In alkaline urine there is always a very large deposit of phosphates and urates.

Bacteriology of the Urine.

That the specific microbe is excreted in the urine of patients was first demonstrated by Horrocks and the writer in 1904, and in 1904-5 the writer further elaborated the work. (Horrocks - Med. Fever Reports I; Kennedy - M.F. Reports III) 2500 specimens (520 with Horrocks) have been examined and the M. Melitensis recovered from 225.

= 9%. 54% of the cases examined gave the microbe,

some of these were examined for a short time only, and where the examination was continued for over 20 days the percentage of recoveries of M.M. was 72.

The technique employed has been fully described in the Reports. After the meatus urinarius had been cleaned with antiseptic the patient passed his urine direct into a sterile test tube or flask; a sterile pipette was used to distribute $\frac{1}{4}$ cc. $\frac{1}{3}$ cc. or $\frac{1}{2}$ cc. of the urine on to the surface of two nutrose-glucose-litmus-agar plates; the plates were incubated upside down at 37°C. for 4 or 5 days. The colonies of M. Melitensis begin to become visible to the naked eye on the third day, but require four days incubation to attain a workable size: a small percentage require five days' incubation. Likely blue colonies were then fished and tested for agglutination against a Malta Fever serum diluted to 1-1000 times. This proving satisfactory the colony was subcultured on an agar slope, placed in litmus milk and tested by Gram's stain.

The results were graphically illustrated by me by inserting the result of the urinary examination in the temperature charts, and some of the more interesting are inserted here. It will be noted that a "0" means - urine examined but no M. Melitensis recovered, a "✕" means - M. Meli-

tensis recovered, and the figures below each red cross mean the number of *M. Melitensis* colonies recovered from each cc. of the urine sample.

A study of these charts shows that the excretion occurs during defervescence and convalescence, and but rarely during the height of the fever. Also that it tends to stop on the approach of a relapse of fever.

The quantity excreted varies from a small more or less regular number daily to a sudden gush of innumerable cocci, and also varies with the duration and severity of the disease.

The time of day at which there is most chance of finding the micrococcus is in the early morning, and the majority of samples examined were obtained at this time.

Reference to charts.

Chart 7, page 91. *M.M.* was isolated post mortem from the urine in the bladder.

Chart 9, page 92, examination of urine during whole of illness. Illustrates well the excretion during convalescence.

Chart 10, page 92, on the 89th day a sudden gush of micrococci appeared - any number between 500 to 800 cocci in each drop of urine.

Chart 11, page 92, excretion during defervescence and cessation on approach of a relapse (50th day).

Chart 15, page 95, excretion irregular but especially in defervescence.

Chart 16, page 95, very slight excretion in a case where infection had become localised chiefly in the lumbar region.

Chart 17, page 95, a similar case to 16.

Chart 20, page 98, excretion during convalescence.

Chart 30. page 127, shows very prettily the excretion during defervescence.

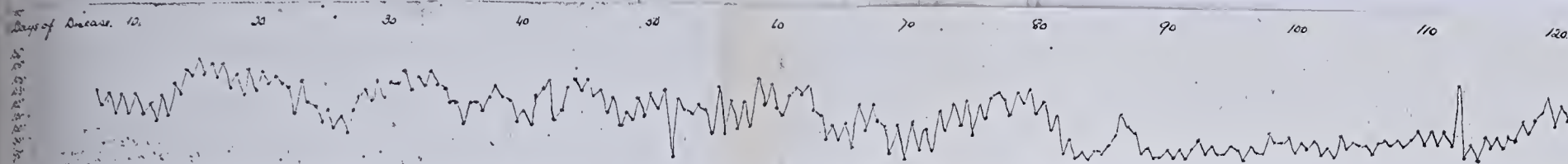
Chart 31 page 127, excretion at the end of a very long case, the chart begins at the 170th day. On the 192nd day a tremendous gush of cocci appeared, the colonies on the plates were quite innumerable and the accompanying photos. 11 and 12 give an excellent idea of its appearance. It will also be noted on this chart that from the 227th day to the 250th, morning and evening samples were examined, and that *M. Melitensis* was recovered from the morning samples 16 times and from the evening 9 times.

The association of mucus with the micrococcus in the urine has been noted above, and experience proved that the micrococci were always more plentiful in the mucus than in any other part of the samples (e.g. supernatant fluid).

The earliest day of disease on which the micrococcus has been isolated from the urine is the 15th and the latest day on which it may be found would appear to be indefinite. An interesting fact was brought out by Shaw (Med. Fever Reports IV) that ambulatory cases of Malta Fever are common amongst the Maltese and that these act as "carriers". To take one case as an example:- A dockyard labourer was found to have *M. Melitensis* in his urine to the number of 26,631 colonies per cc. urine on 5th July 1905. He stated that he had "fever" 10 months previously, but at the time

Case 3. Severe Undulant Type in Neurotic Subject
complicated with retention of urine and cystitis.

Chart 33.



Day.

7. Admitted. Has been employed in laboratory and thinks he contracted the disease there. Serum reacts M.M. incomplete 1-10.
20. Progress has been normal so far, but he is worrying and is of a neurotic temperament, and thinks he can't sleep. No reaction to Enteric.
21. Congestion both bases. Temperature 104° rather high. Irrigation of bowel and hypodermics of strychnine started.
28. Progress very satisfactory until to-day when temperature has risen again. He is becoming very peevish and trying, demanding a great deal of attention.
31. Complaining greatly of his bladder which was found full and forty ounces of urine were drawn off by catheter. Becoming more difficult to manage and aggravating his illness by anticipating and imagining things. The contraction of the sphincter urinae is so great

Photos of Nutrose-glucose-litmus-agar plates inoculated with $\frac{1}{4}$ cc. urine from case of Malta Fever on the 192nd day of disease (vide Chart 31, p. 127) after four days' incubation.



Photo 11.

Fresh urine $\frac{1}{4}$ cc.
Innumerable
colonies of
M.M. - very few
contaminations.

Photo 12.

$\frac{1}{4}$ cc. of same
urine after
being kept 4
days in sterile
test tube pre-
vious to being
planted out on
plate. Note how
pure is the
culture still
and no diminu-
tion in numbers.
Growth is perhaps
not quite so
vigorous as in
the fresh sample.

of his "discovery" his temperature was consistently normal and during the whole of the observations he was never off duty from sickness. The examination was carried out more or less regularly twice a week till the end of 1906 and the first sample was examined on the 3rd July 1905. The following table gives the average daily number of colonies M.M. per cc. urine by months.

Table 8.

Year - Month	No. of observations	Daily Average
1905 July	6	16,000 Colonies M.M. per cc. urine
Aug	3.	3,300.
Sept.	1.	690.
Oct.	7.	3,000
Nov.	8	2,400
Dec.	9.	4,200
1906 Jan	9.	2800
Feb	8	5400
March	9.	1,200
Apr.	8	700
May	9.	2400
June	7	1,800
July	6	1,800
Aug	8	500
Sept.	8	8,200

When I left Malta I made arrangements to have the urine of this man examined regularly, but up to date have not heard the result. Such an extraordinary case is not by any means an isolated one, and the presence of such carriers must be a very important factor in the epidemiology of the disease. It probably has not so much importance as a direct factor but indirectly through the

medium of the lower animals (especially goats) its importance is considerable. The microbe loses none of its virulence by its passage through and its excretion in the urine of man.

Reproductive System.

Male:- The reproductive functions partake in the general irritability or excitation in the beginning. In severe cases with cerebro-spinal irritant symptoms masturbation may be a prominent symptom, it may be uncontrollable and almost an unconscious act, probably there has been a weakness in this direction previously. In a malignant case I have seen the scrotum torn in holes by the nails of the patient in his delirium. Epidydimitis and Orchitis occur in about 5% of cases. It starts as a small hard swelling at the inferior part of the epidydimus, rapidly spreading to the testicle causing some effusion into the tunica and producing a red tense swelling the size of a tangerine orange. I have only seen one case go on to suppuration. No permanent damage is done to the organ. Usually this is a sequel to the fever and occurs as the patient is progressing towards convalescence, it is accompanied by a sharp and sudden rise of temperature (103° to 105°) which rapidly subsides. Frequently however it is the first symptom noted, and in

these circumstances may be mistaken for venereal disease. There is no association between this symptom in Malta Fever and a previous history of gonorrhoea.

An interesting fact and one that I have not seen noted is that seminal emissions occurring during convalescence may be blood stained. Such a symptom naturally causes much alarm to the patient, and his mind should be set at rest by assuring him that the disorder is only temporary.

Female:- The Catamenia are suppressed during a severe attack and dysmenorrhoea and amenorrhoea may be premonitory symptoms.

Pregnancy is not as a rule affected unless the disease be very severe (see also Malta Fever in infants and pregnant goats, Part I p.33.) The milk of women who have had the disease during pregnancy or during the puerperium contains the micrococcus and gives the agglutination reaction. The milk is as a rule so scanty that the child has to be ⁿad fed, or so altered that the child refuses it. The micrococcus has been recovered in large numbers from the milk of a woman who had the disease 18 months previously during the puerperium.

temperature varied between normal and 99° occasionally going up to 100° and his serum did not agglutinate *M. Melitensis* in $\frac{1}{40}$ dilution. I drew off the fluid from his joint and obtained a pure culture of *M. Melitensis*. His history was that six months previously he had been in Hospital for 13 days with what was diagnosed subacute Rheumatism after a wetting, and that ever since, he had suffered from pains which finally settled in his shoulder. This man evidently never suffered from an attack sufficiently severe to give him an appreciable degree of active immunity, consequently the organism finding itself in the more or less stagnant synovial fluid was able to settle down.

That the *M. Melitensis* always finds a man's weak spot is a saying especially true of the nervous system, whether mental or physical, and where symptoms become unduly prominent one looks for some predisposing cause. It may be exposure to draught, prolonged pressure on the buttocks and sacral regions through lying in bed or a neurotic tendency.

The sensory nerves most frequently affected are the Sciatic, Sacral and Lumbar. Sciatica in a very severe form occurs in about 10% of cases, a much larger proportion being affected in a milder degree. It renders the patient quite helpless and the least movement is almost unbearable. Pain

in the coccygeal region is frequently associated with it.

When the Lumbar and lower dorsal nerves are affected there are girdle pains, severe intestinal neuralgia and colic, and neuralgia of the ileo-inguinal associated with excruciating lumbago - fortunately this is not very common.

With regard to motor nerves:- Urination and defaecation may become involuntary and the tendon reflexes exaggerated.

The Vaso motor and nutritive functions are disorganised and great care is necessary to avoid bedsores.

Cerebral and Mental Functions:- In the initial invasion stage with slight pyrexia there may be cerebral stimulation, which in the writer's case was evidenced by a brilliant innings at cricket. Sleeplessness is a pronounced symptom with general irritability. In severe cases there is cerebro-spinal irritation and perhaps pressure symptoms:- for instance - take the case represented by Chart 5, p. 91; on the 8th day and since admission - intense headache. 11th day, sleeplessness; 12th, restless and rambling. 13th, wild delirium - pulse 116; 14th, no sleep, noisy delirium; 15th, very wild, trying to get out of bed, constant muscular jerking, slight retraction of head, unconscious; 17th - quieter, unconscious, pulse

136; 19th - unconscious, constant muscular jerking, pulse 156, death. (see morbid anatomy). Delirium of a less violent type is common, with mild hallucinations and delusions.

Temporary mental enfeeblement is usual and with a neurotic tendency the results may be serious. Cases with such a tendency develop hysteria and refuse food or imagine themselves worse than they are. One case actually developed retention of urine followed by cystitis, because he said his father had suffered from cystitis.

Mental depression is a pronounced effect of the disease and may develop into Melancholia or Delusional Insanity.

In three cases I have seen a peculiar form of epileptiform seizure accompanied by a rapid pulse, sometimes uncountable, tetanic movements, rolling of the eyeballs and complete unconsciousness. It usually occurs as the climax of a rapid rise of temperature, and may be followed by a profound state of collapse.

After severe cases a mild form of paraplegia of the ~~lower~~ extensor muscles below the knee may be present, and is due to wasting and neurasthenia. There is usually tingling and hyperaesthesia of the dorsal aspect of the toes and foot extending up the leg due to the pressure of the bedclothes.

Locomotory System.

What I have said in my remarks on the Nervous System with reference to the relative severity of pyrexia and local symptoms refers also to arthritic symptoms.

Effusion into joints and bursae occur in 30 to 40% of cases and are more often multiple than single. I do not, like other observers, attach much importance to the order of frequency in which the various joints are affected, as I believe that their occurrence is more or less accidental and can be explained by some exposure to cold or pressure, undue exertion, or idiosyncrasy of the patient. For instance Hughes states that the hip is most frequently affected; this is not my experience, as a very small proportion of my own patients were so affected, indeed a larger proportion suffered from effusion into the costochondral, costosternal or sternoclavicular articulations, a complication not mentioned by Hughes. In the writer's own case the sitting posture and supporting the elbows on an armchair accounted for effusions into the ischial and the olecranon bursae, and an increase of walking exercise occasioned the synovitis of the ankles. It has been suggested that the pressure of the bedpan and the stretching to reach the bedside

table may be the exciting causes of hip and sciatic trouble on the one hand and shoulder on the other.

The joints most frequently affected are the ankles, knees, hips, ileosacral, vertebral (lumbar and lower dorsal) shoulder, elbow, wrist, fingers, sternoclavicular, costochondral and costosternal.

The effusion may be acute, subacute or chronic. The acute appears suddenly, produces a hard tense swelling, rarely any redness, is very painful and is accompanied by a rise of temperature: it may disappear as suddenly. The chronic is illustrated by Case 1 (vide R.A.M.C. Journal, March 1905) mentioned under the Nervous System, page 132, where the organism was isolated from the shoulder joint. This case was rapidly cured by drawing off the excess of fluid and injecting 1-80 carbolic solution. I believe this was the first case in which the organism was isolated from a joint, and I have since demonstrated its presence in other joints (e.g. knee) when the seat of effusion. One of the most troublesome, persistent and fortunately rare is effusion into the sternoclavicular joint, it may attain the size of a hen's egg.

I have never seen suppuration occur in any joint effusion of pure micrococcic origin, except

in the costosternal and costochondral, but of these cases a large proportion suppurate. The pus from them gives a pure culture of *M. Melitensis*. It may be suggested that these effusions into the rib articulations may be the result of the vigorous sponging that my cases underwent as a routine treatment.

Bursitis has been already mentioned, and is common to all those bursae liable to frequent or excessive pressure.

The Muscles undergo wasting in proportion to the severity of the disease (see photo 9, page 110) and paraplegia of the leg muscles has already been noted. Twitching of the mouth and tremors of the limbs are present in severe cases, especially when complicated with alcoholism. Subsultus tendiⁿum occurs in fatal cases with "typhoid" condition.

MORBID ANATOMY AND POST MORTEM BACTERIOLOGY*

The Post mortem appearances of the disease "per se" are not very striking and as a rule the interest of the examination lies in the presence of some concomitant or intercurrent affection.

General appearance:- Emaciation pronounced except in cases of short duration. Post mortem rigidity passes off soon.

The Integument presents one or several of the appearances previously described: shotty haemorrhages becoming pustular and forming circular depressed ulcers most numerous on the back and flanks. Boils, small ulcers and bedsores over the sacral region. The scrotum may be scratched and even torn in cases with cerebro-spinal irritation. Bruised places due to subcutaneous haemorrhages.

Thorax:- the pericardial fluid is sometimes increased but no inflammation of the membrane has been noted.

The Heart muscle is thin and flabby and the ventricles may be dilated. I have not seen vegetations on the valves. There is generally antemortem clot.

* Results of sixteen P.M. examinations made by the writer or at which writer was present. Some have been already mentioned in Med. Fever Reports, vols. IV and VI. Instances where interesting complications were present are more fully described further on.

The lungs are always the seat of basal congestion which has usually proceeded to a pneumonia of a broncho-pneumonic type with oedema of surrounding parts and choking of the Bronchioles with a frothy secretion. A lobar pneumonia has been noted in a case previously mentioned. Recent pleuritic adhesions are usual in association with the lung affection, and some increase of pleuritic fluid.

Abdomen:- In one case the recti muscles were found ruptured due to excessive retching. There was a great deal of fluid in the peritoneal cavity.

The Intestines present patches of congestion visible through the peritoneal surface but especially marked on the mucous surface. These patches are specially large and numerous in the lower third of the ileum, the injected vessels give an arborescent appearance, there may be some submucous haemorrhages and the contents of the intestines may be dark in places suggesting haemorrhage. The wasted and friable state of the intestines is specially to be noted and is most noticeable in the above mentioned part of the ileum; in this part also the mucous coat is so thin as to be almost invisible, and higher up and in the stomach it looks sodden and swollen. The peyer's patches are not affected.

In only one case (Bousfield - R.A.M.C. Journal - 1906, I. 173) have I seen ulceration of this part of the intestine (the ileum). It was indistinguishable from an enteric ulcer but bacteriological examination gave negative results to *B. Typhosus*. Several such cases have been reported, but I believe the occurrence of such ulcers to be accidental (cp. ulcer of stomach reported further on, p. 162). The large intestine sometimes presents numerous small circular ulcers, and they are associated in my mind with those cases which present a "typhoid condition" in their last stages. The mesenteric glands are usually enlarged, softened and fluctuating, and pure cultures of *M. Melitensis* in enormous numbers are obtained from them. A striking feature in almost every case is the intense haemorrhagic infiltration of the subperitoneal connective tissue and of the muscles in the region of the lumbar vertebrae. This condition extends from the middle line out towards the kidneys and downwards into the pelvis. The Spleen in every case is enlarged, of a dark colour and very friable: it weighs from 17 to 19 oz. or more.

The Liver is enlarged and in long standing cases presents a nutmeg appearance.

The Kidneys are slightly congested but there is

no marked macroscopic change and the capsule strips easily. (see complication Nephritis).

The Brain in cases with cerebro-spinal symptoms shows acute congestion of the meningeal vessels and choroid plexus, with an increase of the cerebro-spinal fluid. This increase may be so marked as to cause distinct flattening of the cerebral convolutions. No macroscopic changes have been noted in cutting up the brain.

The results of the bacteriological examination of 15 cases is tabulated below.

Table 9.

Organ	Times examined.	Times Microcc. Melitensis recovered.
Spleen	15	15
Liver	3	3
Kidney	7	6
Urine	3	1
Lymphatic Glands	7	7
Mediastinal	2	1
Thoracic	1	1
Mesenteric	7	5
Femoral	4	3
Axillary	1	0
Carotia	1	0
Heart's Blood	6	4
Pericardial Fluid	3	2
Bone Marrow	4	2
Bile	9	3
Bile duct and bladder	2	0
Contents of Intestines	5	1
Salivary Glands	3	1
Thyroid Gland	1	1
Suprarenal	1	1
Pancreas	1	1

The tonsils, pleural fluid and cerebro-spinal fluid were examined four times, once and twice respectively, but without a recovery.

The organism is recovered from the following organs in the greatest profusion in order of precedence. Lymphatic glands (when fluctuating) spleen, liver, bone marrow, kidney. The observation that the lymphatic glands were so favourable to the recovery of the organism (Kennedy - M.F. Reports IV) was of the greatest

value from an experimental point of view, as it was proved that the organism remains in these organs long after it has disappeared from all other parts of the body. Therefore it became a routine practice when making post mortem examinations on experimental animals to make cultures from several of the glands. In many cases it was the saving of the experiment when these organs were the only ones containing the micrococcus. The recovery of the organism from the faecal contents of the intestines mentioned above was made by one of the members of the M.F. Commission after repeated failures.

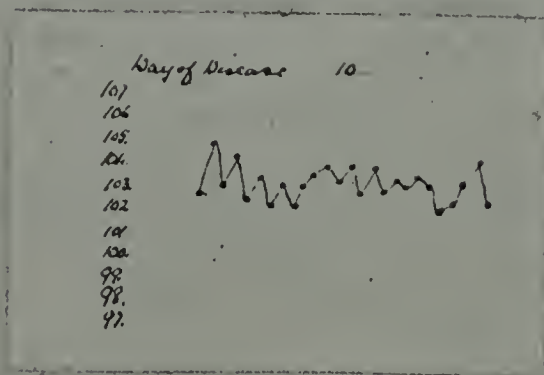
I think that further comment on the results tabulated above is unnecessary.

SOME INTERESTING CASES.

The following are selected from a great number in order to give some idea of the severity of the disease and to illustrate interesting points.

Case 2. Malignant Case simulating Enteric and
Complicated by Pneumonia.

Chart 32.



Day.

- 10th Admitted on 4th day of illness with some diarrhoea and pains in head and back, is seriously ill, light-headed at times, dull and lethargic, pulse slow and intermitting every 5th or 6th beat. Abdomen distended and tymphanitic but no pain and no spots, typhoid like stools. - this was condition on being handed over to me on 10th day of illness. Blood reacts immediately and completely to M.M. and incompletely to E.T.A. in 1-10 dilution. In view of all symptoms is treated as enteric.
- 12th. Abdomen softer - no spots, stools involuntary, very restless and constantly scratching himself, pulse at times very bad. Administration of strychnine hypodermically.
- 13th Pulse improved, has not been so restless, but getting more restless as day proceeds. Congestion of right lung.
- 14th Had a good night, gets restless during day.

Pulse not intermitting so much but very low tension.


15th Got gradually worse during night. Condition this morning like a case of perforation, except that temperature has risen. Sunken appearance, sweat of collapse and running pulse. Death 2 p.m.

Post mortem appearances.

Heart - 10 oz. normal.

Left lung - normal.

Right lung - $28\frac{1}{2}$ oz. the whole congested and the superior lobe in first stage of lobar pneumonia.

Abdomen - contained a quantity of bloody serum - no lymph exudation and no perforation. No ulceration of intestines, peyer's patches normal. Mesenteric glands enlarged and fluctuating. Colon abnormally large. Caecum also much enlarged. Sigmoid flexure took four or five bends and filled up the whole of the pelvic cavity. Liver much enlarged and the gall bladder was folded on itself  possibly causing a syphon action which would account for the contents of the intestines being stained with bile in parts only. This might also account for the constant itchiness of the skin.

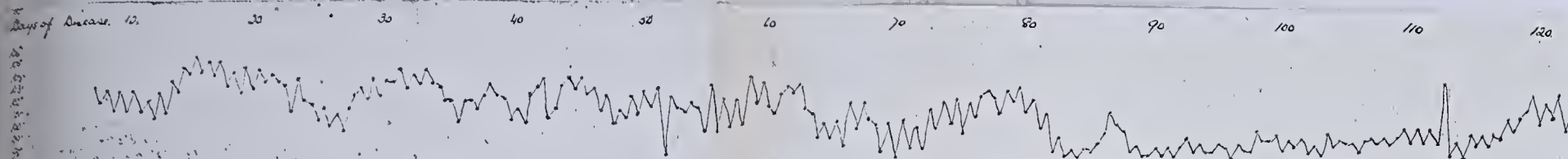
Kidneys - normal.

Spleen - 27 oz. - very dark and friable.

The M. Melitensis was isolated in pure culture (no B.T.A.) from the spleen, kidney, bile and mesenteric glands.

Case 3. Severe Undulant Type in Neurotic Subject
complicated with retention of urine and cystitis.

Chart 33.



Day.

7. Admitted. Has been employed in laboratory and thinks he contracted the disease there. Serum reacts M.M. incomplete 1-10.
20. Progress has been normal so far, but he is worrying and is of a neurotic temperament, and thinks he can't sleep. No reaction to Enteric.
21. Congestion both bases. Temperature 104° rather high. Irrigation of bowel and hypodermics of strychnine started.
28. Progress very satisfactory until to-day when temperature has risen again. He is becoming very peevish and trying, demanding a great deal of attention.
31. Complaining greatly of his bladder which was found full and forty ounces of urine were drawn off by catheter. Becoming more difficult to manage and aggravating his illness by anticipating and imagining things. The contraction of the sphincter urinae is so great

Day

that great difficulty is experienced in passing the catheter. Restlessness and sleeplessness is now marked and requires the administration of morphia. Patient is gradually working himself up into an acutely hysterical condition. Pulse is giving cause for anxiety. Irrigations and strychnine started again. Urotropine.

35. Becoming unmanageable. Very noisy and sleepless.

Moved to a special ward. Ammonium Bromide and hypodermics of Strychnine and Digitalin.

Pulse very low tension 108 per minute. Catheter twice daily.

37. Pulse better tension. Has had very little sleep. Speaks inarticulately. Catheter.

42. In spite of Trional, followed this morning by Ammon. Brom. grs. XX every 4 hours has had no sleep. Urine contains pus and bladder irrigated. Morphia suppository.

44. Has had two wildly delirious nights, might be better described as wild hysteria - foul language etc. Getting increasingly difficult to pass catheter so having passed it, it is tied in. Hypodermic of morphia and Atropine continued each night till 51st day.

51. Has been improvement until last two days, again gets noisy and sleepless. ^{Bladder washed} ~~Catheter worked~~ out twice to-day as urine very foul.

52. This morning urine is quite clear. Hypnotic

changed to sulphonal which is given ~~to~~ in grs. XV t.i.d. Sleeps well. Stools sometimes involuntary.

63. Progress has been variable day by day, but to-day an aggravation of all symptoms, and as he has now become accustomed to all the usual hypnotics and sedatives and not to be affected by them a hypodermic of Hyoscine hydrobromide gr. $\frac{1}{200}$ was given last night with excellent result. This was continued nightly with good results even on the temperature (see chart) until the
- 66 day. At 4 a.m. the hyoscine was injected. At 6 a.m. he sprang out of bed, then fell back in a convulsive fit, foaming at the mouth, a running pulse, and very flushed with a bluish tinge. When seen by me at 7.15 he was twitching all over, quite sensible, pupils dilated, pulse regular and not bad. At 9.30 twitching gone, sweating, temp. 100° and pulse 120 feeble.
71. Much improved and quiet, until to-day when it is necessary to administer Ammon. Brom.
78. (see chart) With a relapse of fever his neurotic symptoms become aggravated and there is recurrence of the cystitis.
79. Administration of Strych. and Digitalin and irrigation of bowel. ~~And~~ Urotropine.

Day

83. Temperature normal.

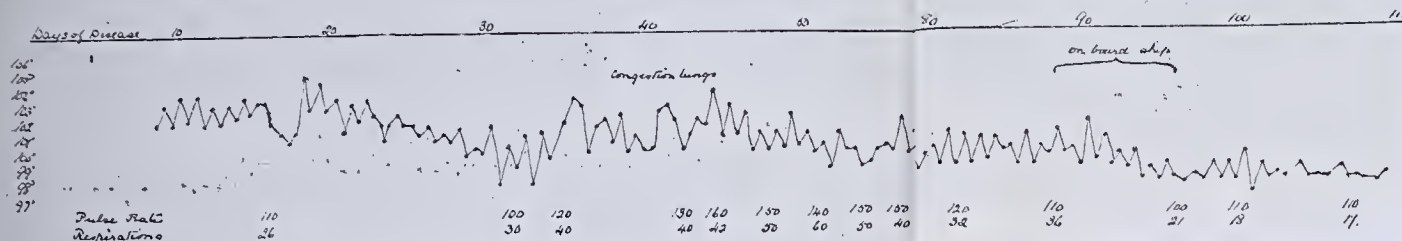
90. Pus still present. Gets so hysterical when trying to pass catheter that it has to be given up. He is able to pass urine himself now.

Further progress of the case of no special interest. He was invalided to England on the 122nd day and made a good but very protracted recovery. The cystitis gradually disappeared and what delayed his recovery most was a condition of paraplegia of the extensor muscles of the leg. He returned to duty eighteen months later.

Case 4. Very severe Undulant type.

Mental shock, prolonged delirium. Extreme cardiac debility.

Chart 34.



Mrs. R - wife of an officer takes ill when nursing her husband who has Malta Fever. On being told that her husband has been taken to hospital she gets a great shock and immediately becomes delirious. The delirium is first of all of an acute nature, but it gradually becomes quieter and settles down into a state of incessant muttering and restless delirium, recognising no one. This is her mental condition for the first 55 days, after which there is a steady improvement and she became quite rational on the 68th day.

From the 40th to the 50th day the heart gave cause for anxiety, the sounds almost inaudible and sometimes with a "galloping" rhythm; the pulse rate varied from 140 to 160 and frequently could not be felt. To make matters worse severe congestion of both lungs set in. Nourishment was refused and nutrient enemata had to be administered. From the 60th to the 70th day there was an

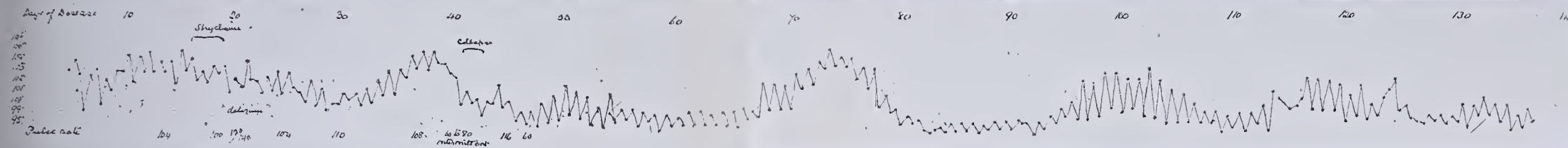
all round improvement. Cough became strong, and expectoration was got rid of. Pulse rate fell between 130 and 150. Effusion into the left pleura occurred but soon cleared up. On the 82nd day she was able to have minced chicken. Pulse rate still high - 100 to 120.

88th day - invalided home to England. Quite helpless and bedridden. Note progress on board ship. (see chart).

In England slight recurrence of temperature. Cough troublesome, expectoration tinged with blood. Pulse still between 100 and 120. Patient arrived in England on the 11th August, and spent all the autumn and most of the winter in a bath chair, regaining the use of her limbs and suffering from a moderate degree of neuritis. In February next the report was "putting on weight rapidly - still feels occasional twinges of Rheumatism".

Case 5. Very severe Undulant Type.

Cardiac debility and syncope. Abscesses.

Chart 35.

Pte. W.- Rifle Brigade. Admitted on 5th day.

Interesting as a chart.

Pyrexia and feeble pulse treated from 16th to 19th day by hypodermics of strychnine and Digitalin and Caffein with good results; pulse rate 100 to 120.

On 4th and 11th day delirium. Pulse rate 100 to 140. Severe second wave with occurrence of abscesses in left arm pit, right breast, and back of ileum. opened on 41st and 44th days.

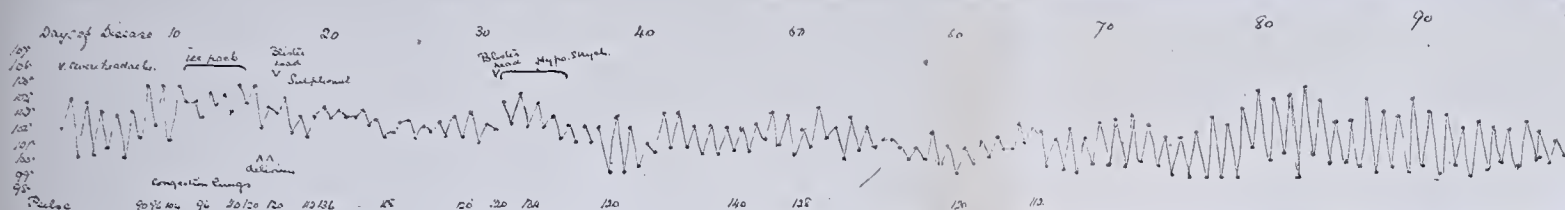
Collapsed condition from 40th to 45th day with an intermittent pulse (every 2nd or 3rd beat).

The rest of the case sufficiently indicated by chart. Nothing special to note.

Case 6. Very severe case similar to Malignant

Type of case but recovering. Cerebro-spinal symptoms successfully treated by severe blistering.

Chart 36.



Sgt. V. - Admitted on 3rd day.

The interest of this case lies in its severity, and ^{it} threatened to end in a similar way to Charts 5 and 7, in death, with acute cerebro-spinal symptoms. On the appearance of cerebral symptoms the head was shaved and a large blister applied on the 31st day and a course of hypodermics of strychnine started. The chart sufficiently indicates the further progress and the patient was invalided home on the 100th day to England, where he made a good recovery after several months in hospital.

It should be noted that the ice pack was tried on the 11th to 15th days but had no effect. The temperature was seldom reduced more than 1°F by it.

COMPLICATIONS AND CONCURRENT DISEASES
WITH ILLUSTRATIVE CASES.

Malta Fever is frequently complicated with other diseases and infections, which may appear in three ways. (1) as a simultaneous infection (2) as an infection arising in the course of Malta Fever and (3) previous to Malta Fever - where the Malta Fever infection is a sequel to the other. The latter is the more common. In 1904 I made a study⁽¹⁾ of the occurrence of Malta Fever in cases previously admitted for some other disease to the Military Hospital Valletta during the years 1897 to 1904, and found that venereal disease was a very long way at the head of the list. This suggested a new line of investigation⁽²⁾ which was followed out later; but the discovery of the infectivity of goats' milk was a sufficient explanation by reason of the dietetic treatment of such cases. And so in a similar way can most of the cases be explained (e.g. Enteric, Jaundice, Nephritis - where milk diet is an essential part of the treatment) when Malta Fever occurs as a sequel.

Enteric Fever as a complication is not uncommon, and is an important point that the Medical Officer in Malta and other places where both diseases are

(1) Kennedy. Malta Fever in the Military Hospital, Valletta, during the years 1897 to 1904.

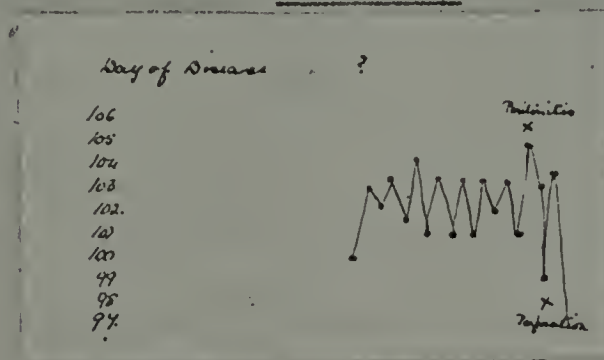
R.A.M.C. Journal May 1905.

(2) vide - Infection by Sexual Congress, Part I, page 59, and Reports M.F.C. VI. page 107.

endemic must not lose sight of. The two diseases may exist absolutely concurrently or the one may follow closely on the heels of the other. The following three cases are illustrative.

Case 7. This was reported by me in the "R.A.M.C. Journal" March 1905, and I believe it to be the first and only case⁽¹⁾ in which the organisms of both diseases have been isolated from the same spleen, though previously a good many cases had been diagnosed to have a double infection by means of the serum test.

Chart 37.



A'Corporal B. - 1st Rifle Brigade was admitted to hospital on the 10th November 1904 on the 4th day of illness according to his own statement. He had no previous admission for fever in Malta but had been under treatment for Syphilis in and out of hospital for the previous six months. His symptoms were typically enteric and the serum reacted incompletely to enteric and not at all to Malta Fever in dilution 1-10 in a quarter of an hour.

(1) Lancet. March 24th, 1906, page 861.

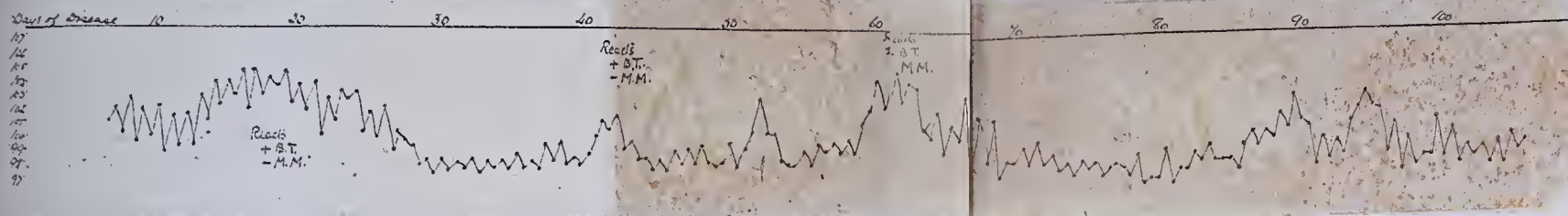
The case went on as an ordinary case of enteric till the 17th Nov. when there was pain in the abdomen and symptoms of peritonitis appeared. Perforation took place next day and the patient died on the 19th Nov.

At the Post mortem the usual appearances of a perforated enteric ulcer and ulcerated intestines presented and the bases of both lungs were congested. The spleen weighed $9\frac{1}{2}$ oz. and cultures were made from it on two plain agar and three nutrose-glucose-litmus-agar slopes. By the 25th Nov. growth had appeared on all the tubes but one. Of the four one contained a pure growth of *B. Typhosus*, two a pure growth of *M. Melitensis* and one *M. Melitensis* and a slight contamination. The two organisms were put through their confirmatory tests.

I regret that no further observations on the agglutination reaction beyond the one on the 13th Nov. were made, but there was nothing in the clinical aspect of the case to suggest the necessity. Had this case recovered, the micrococcic infection would no doubt have made its presence evident as the enteric symptoms subsided, and one would have no doubt been hard put to distinguish between it and a relapse of enteric. In this case the infections must have been as nearly as possible simultaneous.

Case 8. illustrative of Malta Fever occurring as a sequel to Enteric.

Chart 38.



Pte. W. - Rifle Brigade was admitted on the 30th May 1905 on the seventh day of illness and passed through a typical attack of Enteric Fever. His temperature became normal on the 29th day. His serum reaction was complete to enteric in dilution 1-50 and negative to Malta Fever 1-10.

For subsequent course of temperature see chart.

On the 61st day the serum reaction to Malta Fever was present and was more pronounced than the enteric. He was invalided on the 106th day.

During the Malta Fever "waves" he suffered from hysterical attacks and fits of morbid depression.

Case 9. illustrative of Malta Fever preceding Enteric.

A Corporal in the Rifle Brigade was under treatment for Malta Fever from Sept. 29th 1904 to March 17th 1905. For the last month he had suffered from orchitis - a common sequel. On March 27th he was re-admitted to hospital with fever (104°F) and nothing in his symptoms to give me reason to suppose that it was not an ordinary relapse of

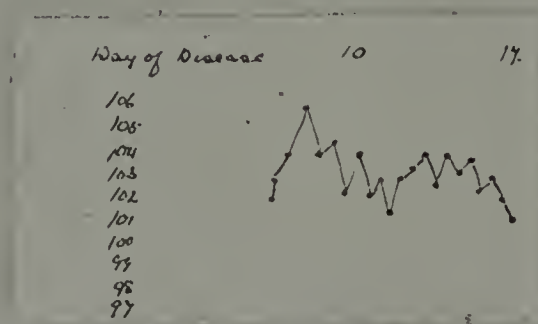


Malta Fever. On examining his blood, however, I found that the reaction to Malta Fever had disappeared and that a slight reaction to Enteric fever was present. I examined the blood on several occasions and got the same result each time. I even drew off five cubic centimetres from the median basilic vein for the purposes of culture but found it sterile. Some doubtful spots appeared about the eighth day after admission, and slight diarrhoea on the tenth, eleventh, and twelfth days. The temperature became normal on the 29th day and remained there till his discharge from hospital.

Alcoholism as a complication is most dangerous and difficult to treat. The cases usually show acute cerebro-spinal symptoms and death may occur during the first attack from heart failure.

Case 10.

Chart 39.



admitted on 7th day of illness.

8th day - slight rigors and partial collapse

after spongeing - Temp. 106°F. in evening.

9th day - tongue very foul.

11th day - inclined to be noisy - tongue dry and

caked.

12th day - very noisy and restless all night -

delusions. Pulse 120 very low tension.

13th day - quieter - Bromides beginning to take

effect. Administration of strychnine seems to have no effect on pulse.

14th day - pulse intermittent and at times

imperceptible.

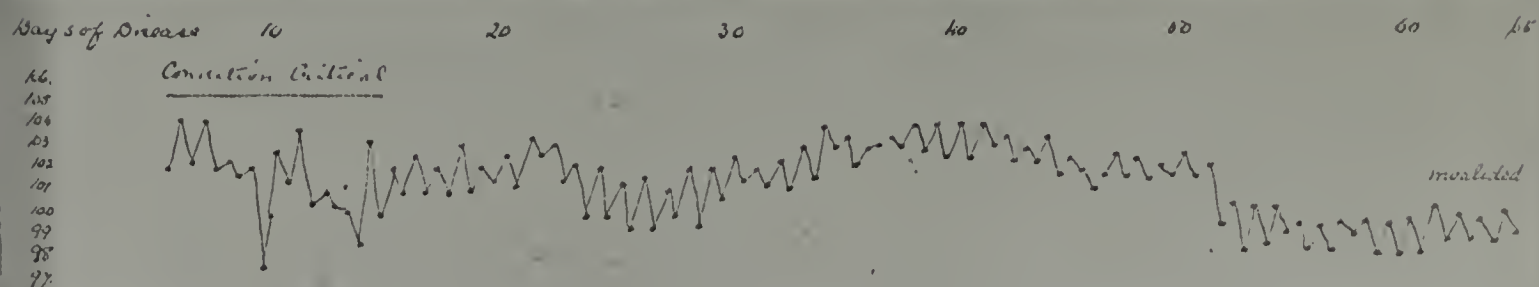
15th day - pulse 140 to 150 per minute.

Patient gradually sank and died early on the 18th day. The case was recognised as being alcoholic and was treated as such from the start with Bromides and cardiac tonics and stimulants.

The only things to be noted post mortem were - a fatty and flabby heart, lungs somewhat congested at bases, intestines injected in places, no ulceration. Liver nutmeg, kidneys normal, spleen 20 oz. friable. M. Melitensis was recovered from spleen and femoral and thoracic glands, but not from mesenteric glands or salivary, tonsils, bile nor marrow.

Case 11.

Chart 40.



This case recovered but illustrates how

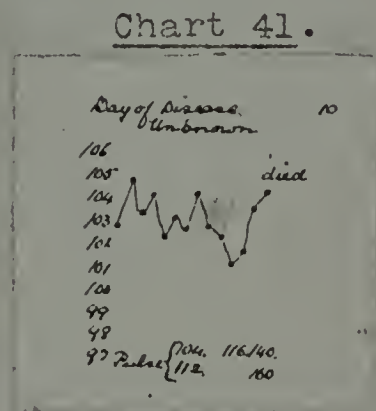
critical is the first part of the illness. For the first six (cp. previous chart) days in hospital it was touch and go. There was tremulous tongue, general muscular tremor, involuntary stools, delirium, restlessness and sleeplessness. Low tension pulse and threatened cardiac failure. He was treated with Ammonium Bromide and 6 hourly hypodermic injections of strychnine. After a week in hospital the case went on as an ordinary one but requiring special attention to the cardiac condition.

Case 12.

Illustrative of severe
Malta Fever in an
Alcoholic subject with
gastric ulcer.

Date of onset unknown.

Came under my care on 4th day



There was an ulcer the size of a shilling on the posterior surface of the stomach near the cardiac end which had perforated and had allowed a very little of the stomach contents to escape. There was no peritonitis and no inflammation round and the appearances led one to suggest that the perforation had occurred postmortem. The stomach contained some semidigested blood. The pancreas was sclerosed. The spleen weighed 170 oz. and gave a pure culture of *M. Melitensis*. The kidneys weighed 5 and 5½ ozs. respectively and also afforded a pure culture, as did also the liver, which weighed 74 ozs. and was fatty; the intestines were normal.

Jaundice as a complication.

I have notes of five cases which suffered from an attack of Jaundice, 4, 3, 2 (2 cases) months and 3 weeks respectively, previous to Malta Fever and one case in which the two diseases were practically simultaneous.

Jaundice is fairly common in Malta and as the treatment is invariably dependent on a milk diet the wonder is that there have not been many more contracting Malta Fever.

Ague as a complication.

Case. 13. Colour Sergt. P- was landed at Malta from a homeward bound troopship as a serious case

suffering from malaria with cardiac weakness, on 4th Nov. 1904. He made a good recovery and was discharged from hospital on the 18th Nov. On the 18th Dec. 1904 he was re-admitted with fever and two days later gave a positive serum reaction to *M. Melitensis*.

His symptoms were now as follows:-

Temperature 103° to 104° F. Pulse 100, fair tension. Heart flabby - no valvular mischief. Great amount of subcutaneous fat.

Severe retching and vomiting due to hepatitis.

Liver very tender to pressure and enlarged.

Pleurisy and effusion right base, secondary to condition of liver. Lungs not primarily affected.

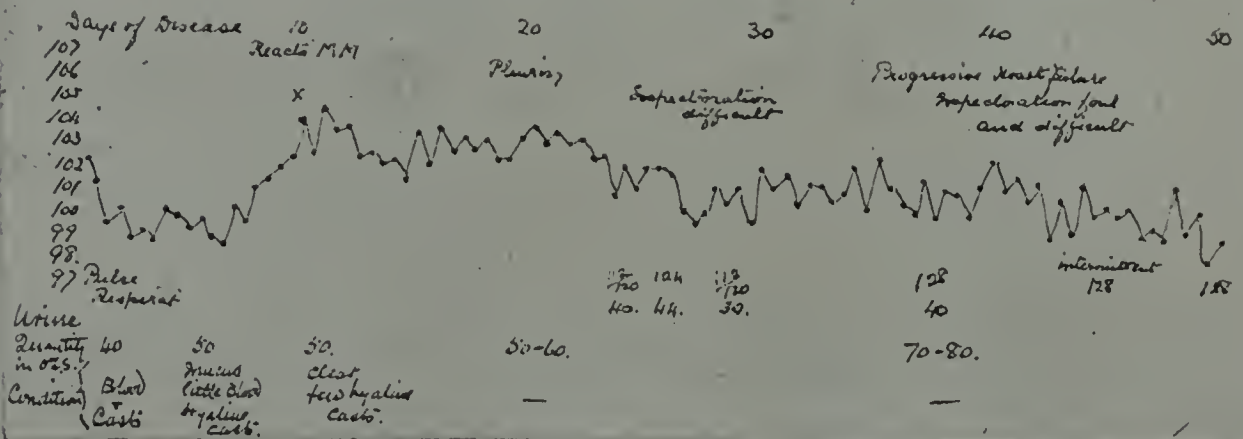
Seriously ill during first "wave". Severe retching and vomiting causing exhaustion and threatened cardiac failure. Liver condition treated by chologogues and sedatives, improved as the temperature fell. With the appearance of the 1st relapse (2nd "wave") the hepatic symptoms again became aggravated but were amenable to treatment. The administration of quinate of quinine appeared to have good effect. Further progress uneventful.

Another case who had suffered from Ague one month previously to contracting Malta Fever suffered from very similar symptoms (vomiting and hepatitis) but there was also an alcoholic history.

Nephritis as a complication.

Case 14.

Chart 42.



Admitted with acute nephritis.

Had nephritis a month ago, and pleurisy in civil life.

Under treatment the condition of urine rapidly improved (see chart). But temperature began to rise again and on blood being tested, the reaction to M. Mollitencia was found positive. He was immediately placed on the serious list for the following reasons:- state of kidneys, condition of lungs (old pleuritic adhesions and chronic bronchitis) and state of heart and pulse.

The progress of the case is sufficiently indicated by the chart. Fresh pleurisy set in, the lung got more and more choked up with secretion which could not be got rid of on account of the old adhesions and which became very foul, in fact a septic broncho-pneumonia set in and progressive

cardiac failure. Death occurred on the 50th day. Post mortem examination:- The heart was covered with lung, was enlarged and flabby and weighed $13\frac{1}{2}$ ozs. The Pleura was adherent all round on both sides. The lungs were emphysematous and contained large patches of broncho-pneumonia which in many places had become septic, with abscess formation. Left lung $51\frac{3}{4}$ ozs., right $63\frac{1}{2}$ ozs. The liver weighed 55 ozs., the spleen 13 ozs., the right kidney $5\frac{3}{4}$ and the left $7\frac{1}{4}$ ozs. The left kidney was partly in the condition of large white kidney.

The intestines showed nothing worthy of note. Cultures of *M. Melitensis* were obtained from the spleen, the kidney and the pericardial fluid.

Case 15. Nephritis occurring during Malta Fever.

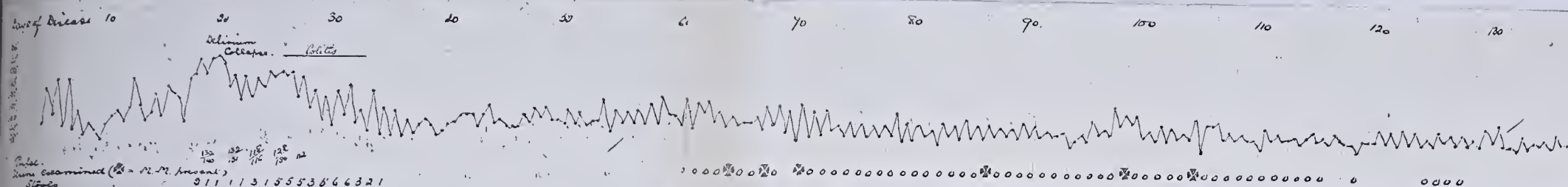
In this case the urine gave evidence that there was a condition of chronic renal disease which had been lighted up into an acute state by the fever. The case progressed favourably and was invalided home.

Colitis as a complication.

Case 16. This was a severe case and interesting from the fact that besides being delirious and becoming collapsed from heart failure he suffered from an attack of colitis. Full details of the case need not be given as the Chart is reproduced in full. Note also the excretion of *M. Melitensis*

in the urine.

Chart 43.



The colitis was not at all severe but there were the usual bloody and slimy stools with tenesmus. It was treated by boric irrigations and the administration of magnesium sulphate.

Concurrent Staphylococcal Infection as a Complication.

The following case is one of the most extraordinary that I have seen, and illustrates how severe may be the invasion of a pyogenic organism and the patient yet recover.

Case 17. Pte. W. - Hants Regt. aged 22 admitted to hospital 23rd Sept. 1904, has served in Malta since the beginning of 1904, is employed as an officer's servant out of barracks.

He is of poor physique thin, and of neurotic temperament. The course of the disease is sufficiently indicated by the chart below and the points to be emphasised are indicated thereon. The blood serum gave a positive reaction to

Pulse

May 1st 20 30 40 50 60 70 80

very noisy & hysterical

abscess

very noisy

Abscess night rupture abscess opened & drained

Abscess night rupture abscess opened

Swelling nose & difficulty breathing

Abscess left side opened

Drains of Pus! Pus passed in house! (Went) Pus leaving pus from Pus

Swelling nose & difficulty breathing

Abscess left side opened

May 2nd 3rd 4th 5th 6th 7th 8th 9th 10th 11th 12th 13th 14th 15th 16th 17th

Pulse all through was weak, soft and rapid and was in a critical state from the 70th to 100th day, making the administration of an anaesthetic a thing of extreme difficulty.

On the 37th day a large oval swelling was discovered over the right scapula extending from the spine to the lower angle of the scapula. It was fluctuating and not particularly painful to the touch. Patient had not complained particularly of pain in this region. The abscess was opened and drained; about half a pint of pus came away, later on some sloughs came away from the cavity. The wound remained gaping for a long time and no granulation tissue was apparent.

Cultures of the pus were taken and proved to be pure growths of a *Staphylococcus albus*.

On the 62nd day it was found necessary to place the patient under ether and open a large abscess on the anterior and external aspects of the right thigh about the junction of the upper and middle third, also an abscess in the left popliteal space. The colour of the pus which was rather fluid was somewhat dark.

On the 67th day another abscess was found in the right leg just below and posterior to the head of the fibula. This was opened under eucaine. On the 73rd day the drainage tube in the left knee was taken out and next day that in the right knee and the tube in the thigh ^{was} shortened. On this day (74th) it was noticed that the urine contained strings of mucus, and two days later pus appeared, and for the next four days was present in great quantities.

On the 81st day the pus in the urine was noticed to be getting less.

On the 84th day a swelling was noticed on the inside of the left thigh about the apex of Scarpa's triangle. It had increased considerably by the 88th day, on which day also pus was absent from the urine. The patient was in such a low condition that the administration of an anaesthetic was fraught with great danger, but on

the 90th day ether was successfully administered and the abscess in the left thigh opened. This abscess was found to be very extensive and had burrowed round about the hip joint. It was drained through an incision made posteriorly.

Fortunately this was the last abscess and to our surprise the patient gradually began to improve. The incisions took a long time to heal up or even to look healthy, and the discharge continued from them all for a fortnight. The further progress of the case is interesting as showing the occurrence of a severe relapse of the M. Melitensis infection after a long period of quiescence. He was invalided home on the 170th day.

The interesting point about this Staphylococcic infection is that the organism must have been avirulent judging from the absence of any indication to the contrary in the temperature. It will be noticed that the evacuation of the various abscesses had little or no effect on the temperature, which follows fairly typically the curves or "waves" of an ordinary Malta Fever chart. Had the organism been a virulent one, recovery could hardly have been made in the circumstances.

It was evident from the condition of the incised wounds (non-granulating) that the re-

cuperative forces were temporarily stunned, and this probably explains the invasion of the system by an organism of such low virulence.

DIAGNOSIS.

The diagnosis in the early stages of the disease from clinical symptoms alone is very unreliable even with experience; the distinctive clinical features are not apparent till late. But we have a reliable means in the Agglutination Test. After an experience extending over many thousand specimens of human serum I am absolutely convinced as to the specific nature of the Malta Fever agglutinins. Several writers have endeavoured to prove their unreliability, but the fault lay in their technique.

The essential for a reliable test is a culture of a recently isolated strain of *M. Melitensis* which has been tested for false clumping against a normal serum. Where Malta Fever is not endemic the culture should be kept vigorous by sub-culturing and by passage through animals. This used to be a frequent, in fact the usual, source of error with workers who did not take these precautions. An old strain will sometimes clump in anything - normal salt or normal serum. Given a reliable culture the rest is simple, and the method I adopt is as follows:-

The Emulsion is made from a fresh agar slope and should be fairly thick (3 standard loopfuls of culture to 1 ccm. of normal salt solution).

The Blood to be tested and some normal blood as control are collected in small capsules and allowed to stand over night; the pure serum is drawn off and a dilution of 1 in 5 made with normal salt. Dilutions of 1-5 and 1-10 of both sera are mixed with equal parts of emulsion and drawn up into sedimentation tubes giving dilutions of 1-10 and 1-20 with each serum. The suspected serum is further diluted and mixed with equal parts of the emulsion to make dilutions 1-50 and 1-100. The tubes are sealed and placed upright for 24 hours. A complete reaction should show a large clump or clumps at the bottom with the rest of the column clear. Before sealing the tubes a drop of the mixture may be placed on a slide kept in a moist chamber and examined under the microscope after $\frac{1}{2}$ an hour.

A reaction in not less than 1-50 dil. is generally accepted as diagnostic in this country, but working with reliable cultures as one can in Malta a complete reaction in 1-20 is sufficient or even a complete microscopic reaction in 1-10 in half an hour. The 1-10 reaction can not however be considered quite satisfactory, as I have seen one case, diagnosed as Influenza and the after history of the case gave no reason to doubt this diagnosis, react incompletely in 1-10 dilution; but this was only one out of many

hundreds. A series of over 100 cases diagnosed S.C. Fever (fever 3 to 4 days) was examined by a brother officer, when the question of these being mild Malta Fever was raised, the dilution used was only 1-5 and none gave a positive reaction.

The paradoxical reaction is very common but usually occurs in the later stages of the disease, therefore the necessity of testing the higher dilutions ($\frac{1}{50}$ and $\frac{1}{100}$) as the lower dilutions may not give the reaction. I first noticed it when examining the blood of goats in Malta and had to make a routine practice of examining each sample in 10, 20, 50 and 100 fold dilutions. It frequently happened that the 100 fold dilution gave a complete and rapid reaction, the 50 was slower and the 10 and 20 none or the merest trace. The reason for sticking to the lower dilutions ($\frac{1}{10}$ and $\frac{1}{20}$) is that in those cases with little or no fever or the chronic type with severe local symptoms or those developing cachexia the reaction will probably be missed in 1-50. The reaction is obtained in the first 10 days of illness (or within the first week in hospital) in 75 to 80 per cent of cases, and these represent the cases with well marked pyrexia.

The reaction may be performed with an emulsion of the dead organism, but is not so satisfactory.

The amount of agglutinating substance in the blood serum of a patient may be extraordinary,

good reactions in 1-1000 and 1-2000 are common and may be present in in 1-10,000.

(See "Prognosis" for further remarks).

Differential Diagnosis.

There are two diseases which give much trouble in their differentiation from Malta Fever - Enteric Fever and Rheumatism.

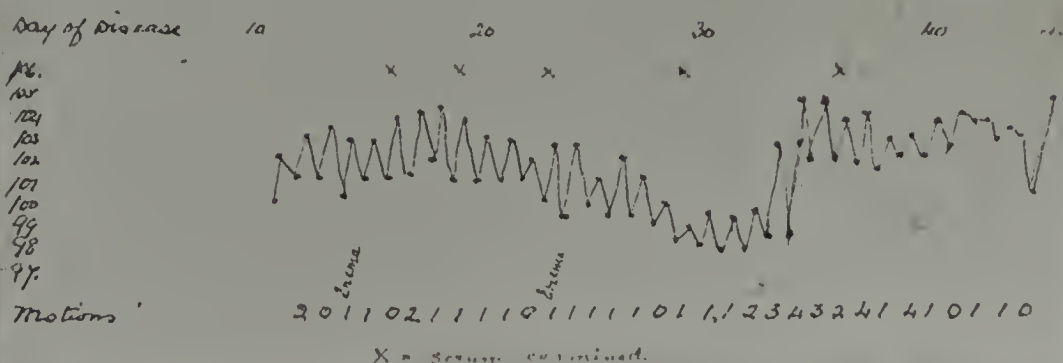
Enteric Fever - In Malta it is imperative to keep in mind two things (1) that Enteric may be a complication of Malta Fever and (2) that the Enteric there is rarely typical as usually understood and the agglutinative reaction to E. Typhosus is not to be depended on. This was frequently my experience. Again, either of these two diseases may so simulate the other as to be clinically indistinguishable.

Enteric as a complication has already been described and the coexistence of the two diseases can only be determined by agglutination or bacteriological examination.

The following case illustrates how enteric may simulate Malta Fever.

Case 18.

Chart 45.



Up to the 30th day there were no Enteric symptoms - no abdominal tenderness, no diarrhoea, no spots and the tongue moist and only slightly furred. All my brother officers who saw the case were certain it was Malta Fever. However the serum tested against *B. Typhosus* and *M. Melitensis* gave a slight reaction to *B.T.* in 1-40 dilution and no trace to *M.M.* in 1-20; the same result was obtained on several occasions. I consequently diagnosed the case as Enteric and treated it as such; for this I was indeed thankful, as a relapse occurred on the 32nd day. There was no uncertainty about the clinical symptoms during the relapse, which was very severe, and the patient died from perforation on the 45th day. The post mortem examination revealed a shocking condition of the intestines. I have never seen intestines in such a rotten state - so extensively ulcerated. The spleen gave a pure culture of *B. Typhosus* and no sign of *M. Melitensis*.

Even on the 36th day the reaction was incomplete to *B. Typhosus* in 1-40 dilution.

The diagnosis in this case was made on the repeated negative reaction to *M. Melitensis* because I was sure of its value but not so certain of the enteric reaction. The strains of *B. Typhosus* used were either obtained from a reliable

source in England or were isolated in pure culture from the spleen post mortem.

On the other hand Malta Fever may so simulate enteric clinically as to deceive the most experienced, particularly when it takes on a "typhoid condition". See case 2, page 146 in which there was abdominal tenderness, tympanitis, involuntary stools and a "typhoid" condition. When such cases further develop intestinal haemorrhage a differential diagnosis is well nigh impossible. It would be folly to say that because the serum reacted to *M. Melitensis* and not to *B. Typhosus* that Enteric was put out of count, and indeed there is really not much to be gained by it when the patient is in such a condition, as the treatment is in either case practically the same.

From Rheumatic Fever, subacute and chronic Rheumatism, Malta Fever is readily distinguished by the serum reaction, and in chronic cases when only one joint is affected with little or no fever and the reaction is absent or indefinite, culture from the synovial fluid will settle the point. The administration of Salicylates has no effect on Malta Fever symptoms.

From Malaria the diagnosis is easily made by examination of blood films, by observing the effect of quinine and by the serum reaction.

Phthisis, Liver abscess and septic diseases with hectic temperature may cause difficulty, but the serum reaction and the presence of physical signs and the history of the case should clear up the case. *A Leucocyte count will also assist.*

The important fact must never be lost sight of - that the specific agglutinins remain in the blood for a long time after an attack of the Fever. In the writer's own case a complete reaction in 1-50 dilution was obtained 3 years after infection; another case (a Pte. R.A.M. Corps) invalided home in 1899 with the disease returned to Malta on the 9th May 1906 (seven years) and reacted completely in 1-50 and incompletely in 1-100 dilution. Therefore in cases with the possibility of a previous infection, for the purpose of a differential diagnosis it is necessary to make a series of daily examinations and note any fluctuations in the degree of agglutination. The following case illustrates the point.

Case 19. A laboratory attendant was inoculated with M. Melitensis vaccine the day after his arrival in Malta and again twenty-five days later, consequently he gave the agglutinative reaction in his serum. He subsequently developed slight fever, but showed no change in his agglutination and was diagnosed S.C. Fever. Two months later he developed an evening temperature and suspicious

symptoms and his agglutination began to rise and steadily increased as he passed through a typical attack of Malta Fever.

Table 10.
Particulars of Case 19. Diagnosis by agglutination.

Date	Reaction	Temperature M. E	Remarks.
May 9.	- $\frac{1}{10}$.		arrived in Malta.
10			inoculated with 400,000,000 dead M.M.
18	+ $\frac{1}{20}$.		
20	+ $\frac{1}{10}$.		
22	+ $\frac{1}{10}$.		
June 3	+ $\frac{1}{10}$.		
5			inoculated with 400,000,000 dead M.M.
17	+ $\frac{1}{20}$.		
28		100.2	
July 1.	+ $\frac{1}{10}$.	99.4. 100.2	Shivering
2.	+ $\frac{1}{10}$ - $\frac{1}{20}$.	101.6	Hospital
3.		99.4 98.8	
4			Wisc. Hosp. diagnos. S.C.F.
Aug. 2	+ $\frac{1}{10}$.		Complaining of Headaches.
30		101.2	pain in neck.
31.		101.	" " "
Sept 1		101.3.	" " "
2.		101.4 102.8	admitted to Hospital.
3	+ $\frac{1}{50}$.		diagnosed Malta Fever.
5	+ $\frac{1}{50}$.		
11	+ $\frac{1}{100}$ + $\frac{1}{100}$.		
17.	+ $\frac{1}{200}$ + $\frac{1}{100}$.		

Previous to inoculating some of the hospital staff their agglutination was tested and an interesting case was noted.

Case 20. A LcCorpl. was found to have a complete reaction in 1-40 dilution. He had no history of Malta Fever and was a recent arrival in Malta. He had no temperature and felt perfectly well. He

had been employed for the previous four months as Masseuse in the Malta Fever wards. This work at that time was constant and pretty heavy, and we explained his reaction by the fact. It had previously been clearly demonstrated (M.F. Reports III) that inoculation of sweat or skin scrapings will produce an agglutination in monkeys without active infection, and it is supposed that by means of the constant and vigorous massage of patients this man had absorbed a sufficient amount of toxin to develop his slight agglutination. His urine was plated out daily for a week but no *M. Melitensis* was recovered. A fortnight later his serum gave only an incomplete reaction in 1-10 and during that time his work had considerably lightened.

PROGNOSIS.

The Prognosis in straightforward and uncomplicated cases is excellent as to recovery but carefully guarded as to duration.

The Mortality is low and varies from 2 to 3 per cent., but occasionally a severe or malignant type may prevail. This once happened in my own experience when an epidemic occurred amongst the members of a sergeants' mess. Sixteen sergeants took ill, the type was very severe and three died. Two were malignant cases and the third death was due to a fatty heart.

Complications must be carefully considered. Those causing death in the early stages are, organic disease of the heart, alcoholism, and pneumonic conditions, and in the later, heart failure, kidney disease, chronic lung complications and phthisis. An old dormant phthisis is almost sure to be wakened up again.

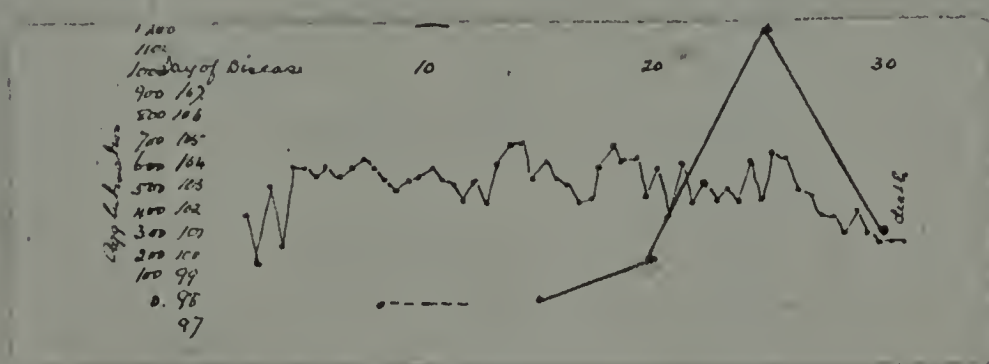
The Duration is quite uncertain, but as a rule those cases with well marked and regular undulant pyrexia have fewer local sequelae, and are able to get about after three months but rarely able for full work for another three. This on the whole is a good average to take, but the variations from this are great.

A small percentage make a complete recovery within three months, but a larger require a year.

Cases of much longer duration are quite common, and recently my attention was drawn to one with more or less continuous pyrexia for two and a half years. One should be particularly guarded in cases with severe neuritic symptoms, as they are frequently of long duration - crippling the patient for years.

Attempts have been made to prognose from observations of the agglutination curve. The following chart gives an idea.

Chart 46.



It will be seen that the appearance of the agglutination was long delayed and that this indicated delay in the formation of protective substances by the body was accompanied by symptoms of a very severe nature and a sustained and irregular pyrexia.

On the appearance of the reaction and its rapid rise there was a simultaneous improvement in the character of the fever. This was not long sustained however as by this time the system was

too exhausted.

It will be noted how the temperature falls in a straight line on the 26th to 28th days. This is always a bad sign and one that should put the physician on his guard at once. It indicates that in some way or other the toxaemia is having the better, and though it is not by any means a necessarily fatal sign it indicates an immediate recrudescence of fever if the system is able to react.

It may be taken as a general rule that cases with a low agglutination have a bad outlook, not so much as regards recovery perhaps but as regards duration of illness.

TREATMENT.

Nothing has yet been discovered which acts as a specific and apart from the recent development of vaccines and antiserums the treatment is entirely symptomatic.

The patient should first of all be carefully overhauled to find out his weak points, in order to anticipate probable complications. This disease above all finds out the weak link, settles on it, and may snap it. Therefore, for instance, a weak heart must be carefully tended and treated from the start with special precautions against the occurrence of pulmonary congestion, an alcoholic must not be deprived of his alcohol entirely and will require special attention to his dieting. In the later stages precaution against damp garments (from sweat) exposure to draught and cold and over-exertion should be taken to prevent as far as possible the occurrence of neuritic and arthritic sequelae. In my experience the best treatment for the various symptoms is as follows:- Headache by Phenacetin and Caffein. Caffein citrate alone may suffice. Phenacetin alone should never be given, it should be given in small doses (grs. iii). Any drug of a depressing nature must be carefully administered and if possible avoided altogether.

Sleeplessness by Sulphonal, best administered in

two doses of 20 grains each, one at 6 p.m. and the other at 8 p.m. Sleeplessness due to neuritic and arthritic pain may require morphia, in draught or hypodermically.

Pyrexia. As a routine treatment cold or tepid sponging varied with an occasional hot sponge is quite sufficient for a moderate degree of pyrexia, and should be done morning and evening, or oftener if necessary, if the temperature is over 102° in the morning and 103° in the evening. Cold baths and ice packs cause too much shock, and my experience with them has been most unsatisfactory. The most successful treatment for Hyperpyrexia is irrigation of the lower bowel with equal parts of water and Boric lotion in which a lump of ice has been allowed to melt. There is no shock and the way the temperature falls is remarkable. In the way of drugs the most useful are Strychnine and Tinctura Ferri Perchloridi. Large doses of Tr. Ferr. Perch. (m 15 to 20) with Pot. Chlorat. grs. X in Ag. Menth. Pip. given six hourly for two days at a critical time in the pyrexial period will frequently cause the desired fall. Strychnine is the sheet anchor in the treatment and is of great benefit all through, but it is invaluable when the continuation of the pyrexia is causing critical danger from heart failure, and will tide the patient over till the desired improvement

takes place. It should under these circumstances be given hypodermically every 6 hours for two to four days at a time and may be given in conjunction with the Tr. Ferri. Perchlor. treatment. It is fortunate that there seems to be a great tolerance for the drug in this disease.

When Cerebral Symptoms supervene the head should be shaved and a large blister applied extending from the front to the back along the middle line. I attribute the recovery of Case 6, page 155, which was one of the Sergeants' epidemic mentioned above, to this energetic treatment. An icebag to the head is sometimes of use but difficult to keep applied on account of the restlessness. In the wildly delirious condition - Ammonium Bromide and hypodermics of Hyoscine are of most use; the latter must be used with great caution (see case 3, page 148). Morphia is uncertain and may even aggravate the symptoms.

With a failing pulse strychnine is a necessity, and may be assisted by Digitalis and Strophanthus. In Acute Synovitis nothing is so efficacious as hot fomentations frequently applied; for the more chronic condition applications of Belladonna are soothing. In chronic effusion of a single large joint drawing off the fluid through a syringe and injecting a little 1-30 Carbolic

lotion gives good results (see Case 1 page 132). For the Neuritic symptoms internal administration of Iron and Arsenic combined with local treatment according to the nerves affected. Cupping over the lumbar region may give great relief when the symptoms point to that region of the spinal column being affected, and blistering over the sciatic. The greatest relief is got from vigorous massage and in chronic bedridden cases this should always be carried out to prevent the wasting of the muscles and the consequent paraplegia of the legs. As a routine treatment from the start the following prescription is of the greatest benefit:-

R. Ac. Carbolic m. ii. Tr. Cardam. Co. m X,
 Ag. 3. i; every 4 hours during the day. It has a wonderful effect in cleaning the tongue, and allaying the gastric symptoms, and acts as a mild diaphoretic. If continued too long it may cause diarrhoea.

The other most useful routine treatment is a pill of Nux Vomica, Belladonna and Aloes. This is invaluable in the constipation of the later stages and during convalescence and its action will be appreciated when the atonic condition of the intestines is remembered. In the convalescent stages the treatment should be tonic. - Easton's syrup. Hypophosphites etc. and where anaemia and cachexia are marked, antiscorbutic treatment gives

the best results.

Many drugs have been tried and highly recommended, but my experience is that nothing will prevent the relapses of fever, e.g. Cinnamic Acid, Chinisol, Lithia mixture, Cyllin, Creasot, Salol. etc. and nothing has yet been discovered to prevent the Bacteriuria. Urotropin, Benzoic Acid, and Peroxide of Succinic Acid (one case appeared to benefit, M.F. Reports VI. 128^{have been tried.}). Quinine is no good and ^{is} harmful unless administered in small doses as a stomachic in the later stages. Salicylates are harmful as they are depressing and have no effect on the arthritic sequelae. The Dieting is important. It is a very prevalent idea that the diet should be strictly liquid throughout; this I emphatically disagree with. The great indication as to the condition of the digestive organs is the tongue; and if the tongue is clean and the patient feels hungry, he should have light solid food, even though his temperature be slightly raised. Provided that the digestive organs are not overtaxed solid food has no influence on the temperature. Many of the cases which become anaemic and cachectic and drag out a long and tedious convalescence might be avoided if the diet had been made more liberal in the direction of some light solid food.

Treatment by Antiserum and Vaccine.

Treatment by these substances is of too recent development to provide any striking results and is still "subjudice".

I have seen decided benefit from the injection of antiserum (prepared from the horse) during a severe relapse which was evidently severely taxing the recuperative powers of the patient. To my mind the indication for the administration of the vaccine is a low agglutinative reaction in a chronic case with low irregular fever and marked local symptoms. The dose should begin with 500,000,000 cocci and rise to 1000,000,000, and the administration regulated by a careful observation of the agglutination. The calculation of the opsonic variation is too tedious for clinical work and I am convinced that for practical purposes the agglutination is a fair indication.

P A R T I I I .

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PROPHYLAXIS.

The result of the research work described in Part I is to show that Malta Fever may be contracted in several ways, but that at the same time it is rarely contracted otherwise than through the medium of milk.

It is evident then that there must be complete and efficient supervision of the milk supply.

(1) The milk itself is rendered safe if pasteurised, as heating it at 60°C . for 15 minutes is sufficient to kill the micrococcus. But it is exceedingly difficult to ensure that every drop of milk used is so treated, especially if one is at the mercy of servants, and where a supply of fresh milk is always handy at one's door, in cases of emergency. Preserved or condensed milk is therefore much safer and should be used where large quantities of milk are consumed daily.

(2) The goats themselves should be carefully examined and the infected ones quarantined or killed off. In the present state of affairs in Malta this is impossible, but it is hoped that in time some legislation may provide for this and for compensation to owners. In view of the long time that the excretion of *M. Melitensis* may continue in the milk, experiments were made to see if inoculating the animal with vaccine had

any effect in cutting it short. The experiments are too few as yet to do more than give an indication that vaccination may be of use. The excretion was certainly stopped in one animal.

Prophylaxis may be considered from another point of view, viz.- that of conferring immunity.

Immunity.

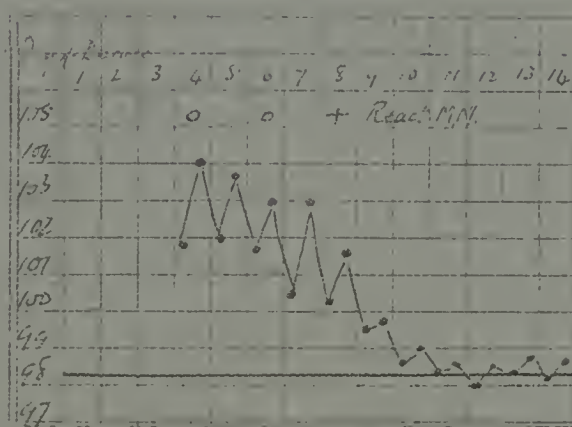
Not many years ago the Maltese considered that they were not liable to the disease. This was merely because their physicians failed to recognise it and did not notify cases of illness until they got seriously ill, when a diagnosis of Enteric was made. There is evidence, however, that a marked degree of immunity may be acquired as the result of one attack. The proportion that suffer from two infections is small, but one not infrequently comes across cases. In many it is impossible to say whether the second infection is really a new invasion or merely a reawakening of the organism which has been latent in the system. We know that the organism may not be completely eliminated for years, and in the case of so-called reinfections occurring within two or three years there is room for doubt.

The following is an undoubted case of a second infection.

Case 21. Corporal McG - suffered from the 16th Feby. 1898 to the 9th Aug. 1898 from a severe

attack of Malta Fever followed by orchitis, debility and severe anaemia. He left Malta soon after and returned with his regiment on the 21st April 1904 after an absence of at least five years. He was admitted to hospital on the 27th March 1905 on the 4th day of disease. (see Chart 47)

Chart 47.



He had an exceedingly mild attack which might be classified as an aborted case. His blood serum gave no reaction to *M. Melitensis* in 1-10 dilution on the 4th day (1st day in hospital) or the 6th, but on the 8th the reaction was present. He had no relapse.

My experience has been that it is rare for one who continues to live in the endemic area after he has recovered from one attack to become infected a second time, but it is quite common for one who has been out of the endemic area for some years to succumb a second time on his return. Arguing from this it would seem that the Maltese become protected to a certain extent; and the fact that though such a large proportion of them (10 to 15%)

are infected yet only about one out of every two hundred of population developes symptoms of sufficient severity to warrant their medical attendant notifying the case, is additional evidence.

The immune bodies present in infected blood can be indicated by phagocytic and agglutination tests (opsonins and agglutinins). There seems to be no bactericidal action in the fluid portion of the blood, at least none has been demonstrated, and one experiences no difficulty in culturing the organism in either normal or immune blood.

With a view to getting some idea of the length of time the immune bodies may persist in the blood, I examined my own blood. I contracted the disease in Sept. 1903, was invalided to England January 1904 and returned to Malta in April 1904. I had no return of the Fever and on expiration of my foreign tour returned to England in Oct. 1906. In the summer of 1906 my serum reacted to *M. Melitensis* - $\frac{1}{10}$, $+\frac{1}{20}$, $+\frac{1}{50}$, $+\frac{1}{80}$, the paradoxical reaction being well marked.

In January 1908 (4 years after attack) my agglutination was $-? \frac{1}{8}$, $+\frac{1}{16}$, $+\frac{1}{32}$, $-\frac{1}{64}$ against a normal blood $+\frac{1}{8}$, $-\frac{1}{16}$, $-\frac{1}{32}$. The strain of *M. Melitensis* used was an old one, and this accounts for the positive reaction with normal

serum in $\frac{1}{8}$ dilution. It will be seen that though there is still an agglutination it is very feeble, but the paradox is still indicated.

The Opsonic value of the serum was also tested in January 1908 and was estimated by a modification of Klien's method for Bac. Typhosus - namely - by finding the highest dilution of serum which will give a definite amount of phagocytosis.

The following is the method employed:-

The Emulsion is made fairly thick - $1\frac{1}{2}$ loopfuls of a 48 hour culture to $\frac{1}{2}$ cc. saline solution. The blood cells are washed in the ordinary way. The serum is used neat and in dilutions 1-4, 1-8, 1-16 and 1-32, and a normal serum is used as a control in dilutions of 1-4, 1-8 and 1-16.

Equal parts of the serum (or dilutions of serum) cells and emulsion are mixed together by means of a pipette on a slide, drawn up again into the pipette, which is sealed off and placed in a water bath at 38°C . for 10 minutes. At the same time a control with equal parts of salt solution, cells and emulsion is also incubated. At the end of the 10 minutes the contents of each pipette are blown out on to a slide and a film made and stained.

The following table gives the result of the phagocytic count.

It should be noted that the final dilution of the neat serum is 1-3, of the serum diluted 1-4, 1-12 and so on.

Table 11.

Serum Dilution	No. of Micrococci phagocytosed per cell by		
	Normal serum.	Immune serum	Normal Salt.
1-3	30 +	25.4*	0.3
1-12	.62	26.0*	-
1-24	.42	2.5	-
1-48	.15	.82	-
1-96	-	.42	-

* Evidence of bacteriolysis.

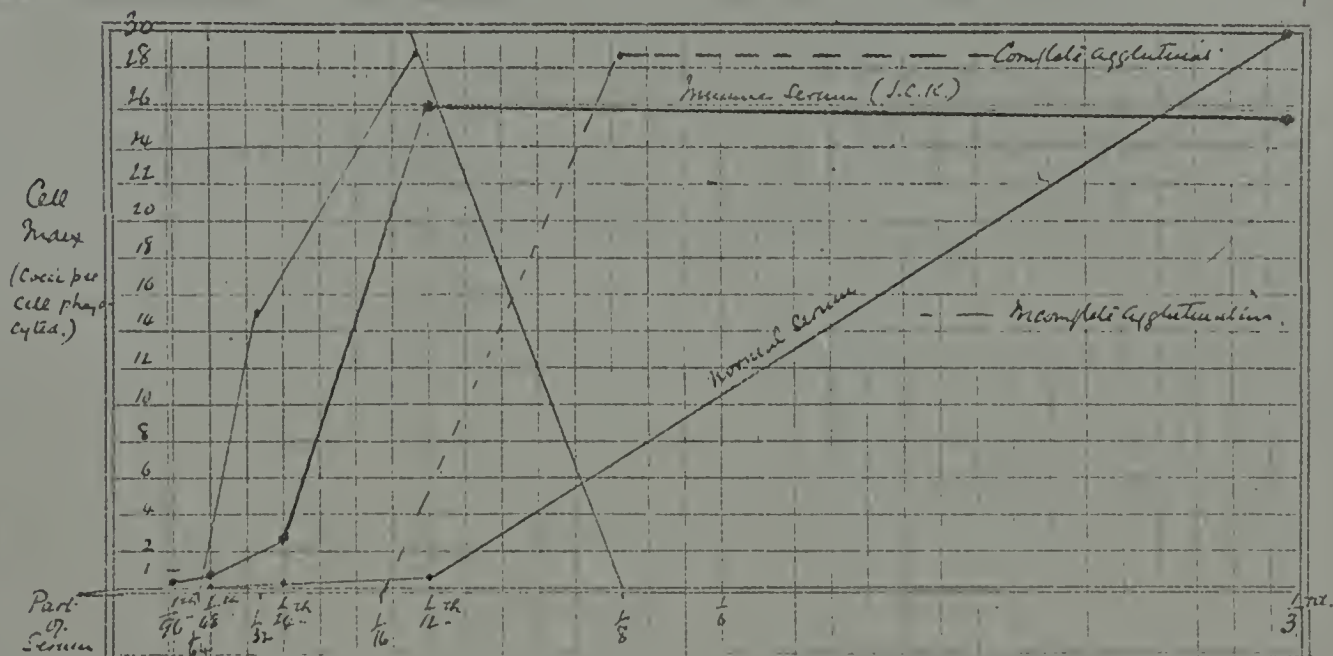
0.3 represents the amount of spontaneous phagocytosis which may be present in normal salt and denotes the utmost limit of significance, therefore a point well inside the limit is taken.

0.62 is a figure well within the limit but evidently near the end point. Therefore the dilution of serum necessary to give a phagocytosis of .62 per cell will be a means of comparing the relative values of the normal and the immune serum.

With the normal serum the end point is reached in 1-12 dilutions and with the immune serum somewhere between 1-48 and 1-96 dilutions (at 1-72). Therefore the immune serum has six times the value of the normal in respect of its opsonic content.

Chart 48.

showing the Opsonic and agglutinative value of blood serum of a person immunised by an infection occurring four years previously compared with the blood of a nonimmunised person.



The black lines denote the phagocytic index of the two sera in respective dilutions.

The red lines denote the presence of complete or incomplete agglutination in the dilutions of the two sera. The interrupted red line is the normal serum.

As the result of a good deal of work with the dilution method (Klien) for estimating opsonic content as applied to Typhoid, I have come to the conclusion that it is a most valuable method. It demonstrates clearly that the agglutinins and the opsonins formed in the blood as the result of - say - inoculating with small doses

of vaccine, appear nearly simultaneously and increase correspondingly (though I am inclined to think that later on the agglutinins disappear rather sooner than the opsonins). If this observation holds good in every case and under all conditions we should be relieved of the burden entailed by opsonic estimation and rely on the agglutination reaction as an estimation of the amount of active immunity present.

The question of conferring immunity has been studied by several workers (Wright, Eyre, Shaw). Wright prepared a vaccine but failed to confer immunity in his own person.

Eyre⁽¹⁾ working with an antiserum prepared from the horse found that it did not lessen the effects of a minimal lethal dose of *M. Melitensis* for guinea pigs unless it were inoculated along with the organism.

Shaw⁽²⁾ found that monkeys who had previously had an attack of Malta Fever reacted much less markedly than others which had not, to the same dose of living *M. Melitensis*, which agrees with what I have already stated for man. He also found that in monkeys inoculation with a vaccine previous

(1) Eyre. Reports M.F. Commission V. p. 42.

(2) Shaw " " " V. p. 24.

to inoculation with a dose of living *M. Melitensis* had a distinct effect in lessening the fever.

In April 1906 some of the R.A.M. Corps orderlies in Malta were inoculated with a vaccine prepared by Dr. Eyre in doses of 200 or 400 million cocci. Where possible a second dose was administered. We found that the agglutination appeared to the extent tabulated below.

Table 12.

The result of inoculations of 30 men with a vaccine of *M. Michtensis* as tested by agglutination after each dose and at the end of four months.

No. of men	Dose of vaccine.	No. of men reacting in each dilution									
		after 1 st Dose.					after 2 nd Dose.				
		nil	1-10	1-20	1-50	1-100	nil	1-10	1-20	1-50	1-100.
16	Inoculated once Dose 400 mill.	1	2	3	5	5.				2	5
										8	-
										one not examined.	
8	Vaccinated three 1 st Dose 200 mill 2 nd Dose 400 mill.	5	1	2	-	-	1	1	4	2	2
										4	-
6	1 st Dose 400 mill 2 nd Dose 400 mill	-	3	3	-	-	-	1	2	2	1
										2	1
30	Totals.	6	6	8	5	5	1	2	6	4	1
										8	11
										1	-

An examination of this table shows that the agglutination soon tended to disappear.

The value of this experiment can never be determined, because at the same time the supply of goats' milk was stopped, and as a result only four cases occurred that year in the Detachment R.A.M.C. at Valletta. Two occurred in the uninoculated, who totalled 38 excluding those who had previously had Malta Fever, and two in the inoculated. One of the latter is the case described on page 178 (Case 19 - table 10) who had a fairly severe but a typical and uncomplicated attack, the other was a very mild case in which "rheumatic" symptoms predominated.

We are forced to conclude therefore that the use of vaccine and antiserum as prophylactics has not yet been demonstrated.

RECENT EPIDEMIOLOGY AND THE EFFECT OF
PROPHYLACTIC MEASURES.

Previous to 1906 nothing was found to have any relationship with the incidence of the disease except Season. The Naval, Military and Civil Statistics all agreed in this respect. The incidence of the disease varied in proportion to the temperature and inversely with the rainfall. Age and Sex afforded no clue; the sexes were equally liable and although those between 16 and 25 years of age provided the greatest number of cases yet infants, children and aged people were all liable.

In the Autumn of 1905 when the infective nature of milk was established, special precautions were taken by the Naval and Military authorities to ensure all milks being sterilised before use, but it soon became evident that efficient sterilisation of every drop of milk used could not be depended on. In this connection the Ortol test described by Saul was of the greatest use in detecting unboiled milk and was introduced by one of the members of the Commission. The Ortol test is as follows:-

A 1 per cent solution of Ortol (ortho-methyl-aminophenol sulphate) and Peroxide of Hydrogen - a few drops of each - added to raw milk or milk that has not been heated at or above 70°C . gives

a brick red colour in 30 seconds.

In May 1906, as I have already pointed out (Part I, page 32) the Military authorities stopped the issue of goats' milk to the troops. In the Naval hospital very special precautions were taken from the beginning of April 1906 to ensure that all milk was carefully sterilised, but even this was not found satisfactory, and preserved milk has been used ever since July 3rd 1906. On the arrival of the Fleet on Aug. 6th the Commander in Chief issued an order that all milk was to be boiled and the Ortol test applied every day, and a signal to that effect to be made to him each morning.

The result of these measures is sufficiently striking:

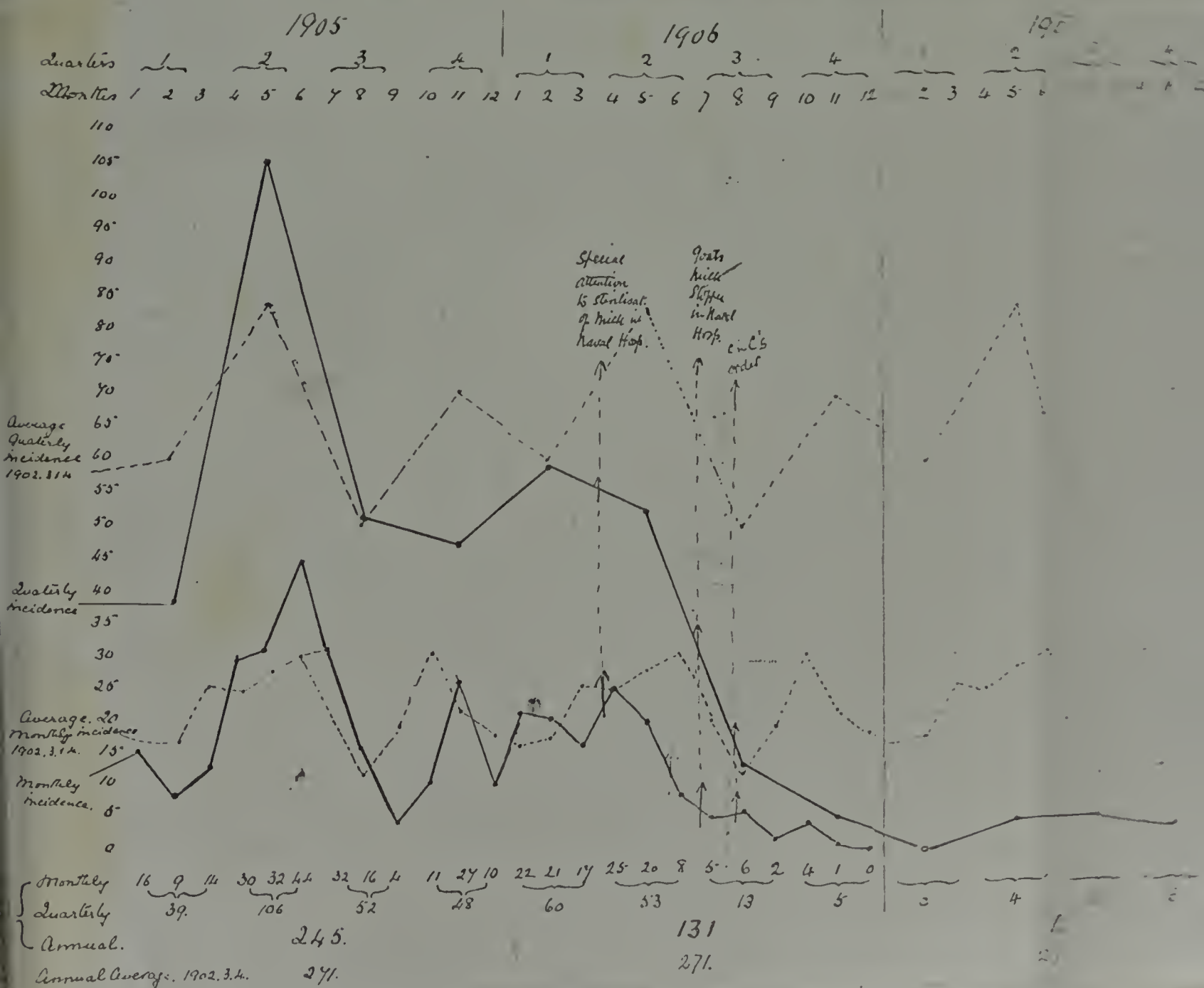
Naval:- During the years 1902-5 the Naval hospital was responsible for the infection of 104 cases annually or 26 per quarter. During 1906 infection from the Naval hospital could be traced in 51 cases, of which 50 occurred in the first quarter and 1 in the second quarter. Since the middle of 1906 up to the end of 1907 not a single case has contracted infection in hospital.

As regards the whole Fleet in Malta the following chart shows what a great reduction has been effected. It will be observed that the annual average admission rate for the years 1902,

3 and 4 was 271, for 1905 the number of admissions was 245, for 1906 only 131, of which 113 occurred in the first two quarters and for 1907 only 12. Of these, only 3 were seamen or marines from the Fleet, 5 were Englishmen living on shore and 4 were Maltese chiefly domestics.

Chart 49.

Showing the Incidence of Malta Fever in the Fleet during the years 1905, 6 and 7, indicating the dates on which prophylactic measures against milk were adopted and comparing with the average admission rate for the previous three years 1902-3 and 4.



As the quarterly admissions only are as yet available for 1907, a quarterly curve for the previous years has been introduced for comparison.

The dotted lines are the average monthly and quarterly admissions respectively for the years 1902-3-4.

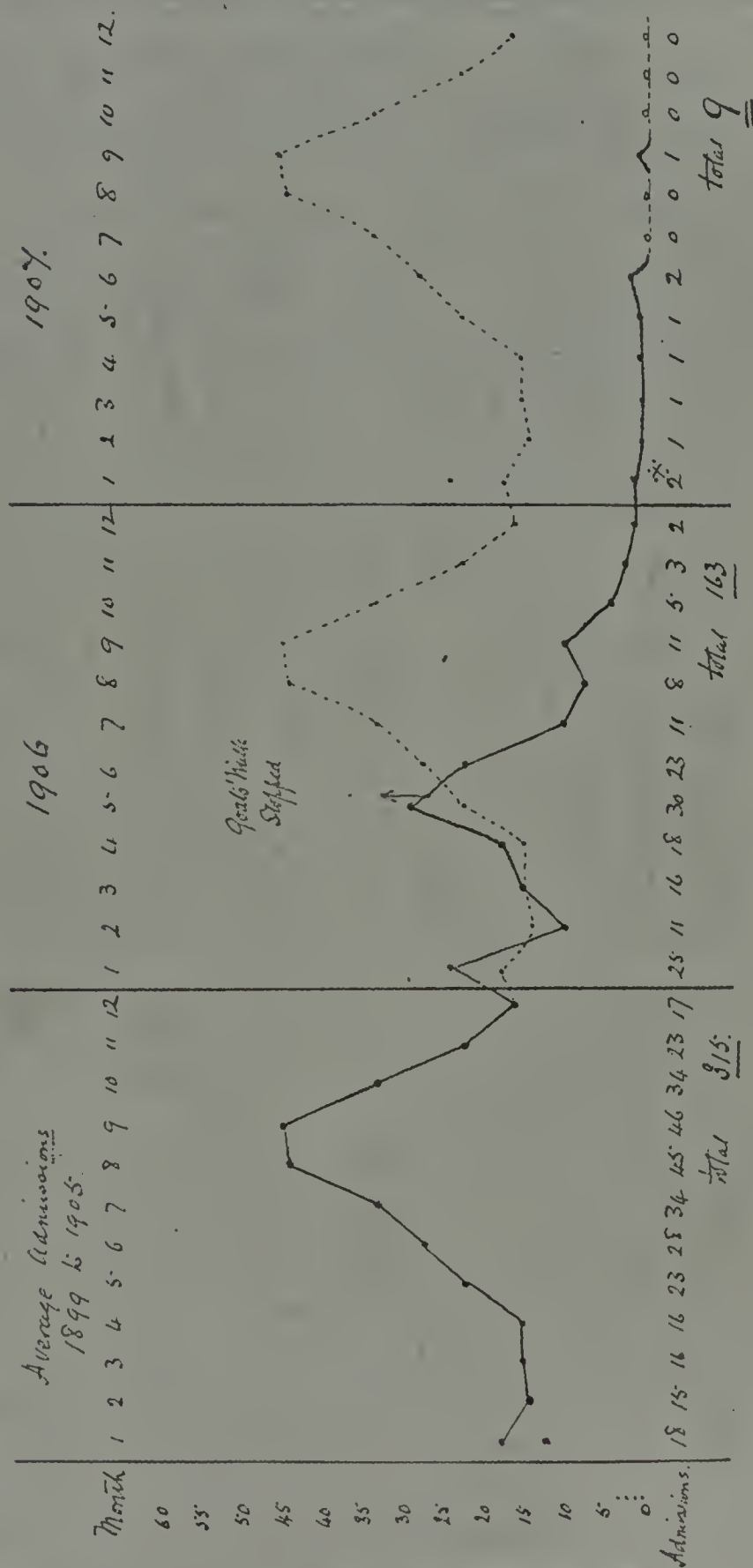
Military:- During the years 1897 to 1905 there were 2687 cases of Malta Fever amongst the N.C.O's and men of the Garrison, giving an average ratio of 36.2 admissions per 1000 of strength per annum. During the year 1906 there were 163 admissions, giving a ratio of 24.5 per 1000 strength. Of the 163 admissions 123 occurred in the first half of the year (goats' milk stopped in May). During last year (1907) the admissions were only 9, giving a ratio of 1.9 per 1000.

It should be added that two of the cases in 1907 (both in January) were relapses from the previous year, and that in 1906 there were 19 readmissions for relapse.

Chart-50.

Showing the incidence of Malaria Fever in the rank and file of the Malta Garrison (military) during the years 1906-7 compared with the average for the previous seven years (dotted line).

Admissions for Malaria Fever in the Army.



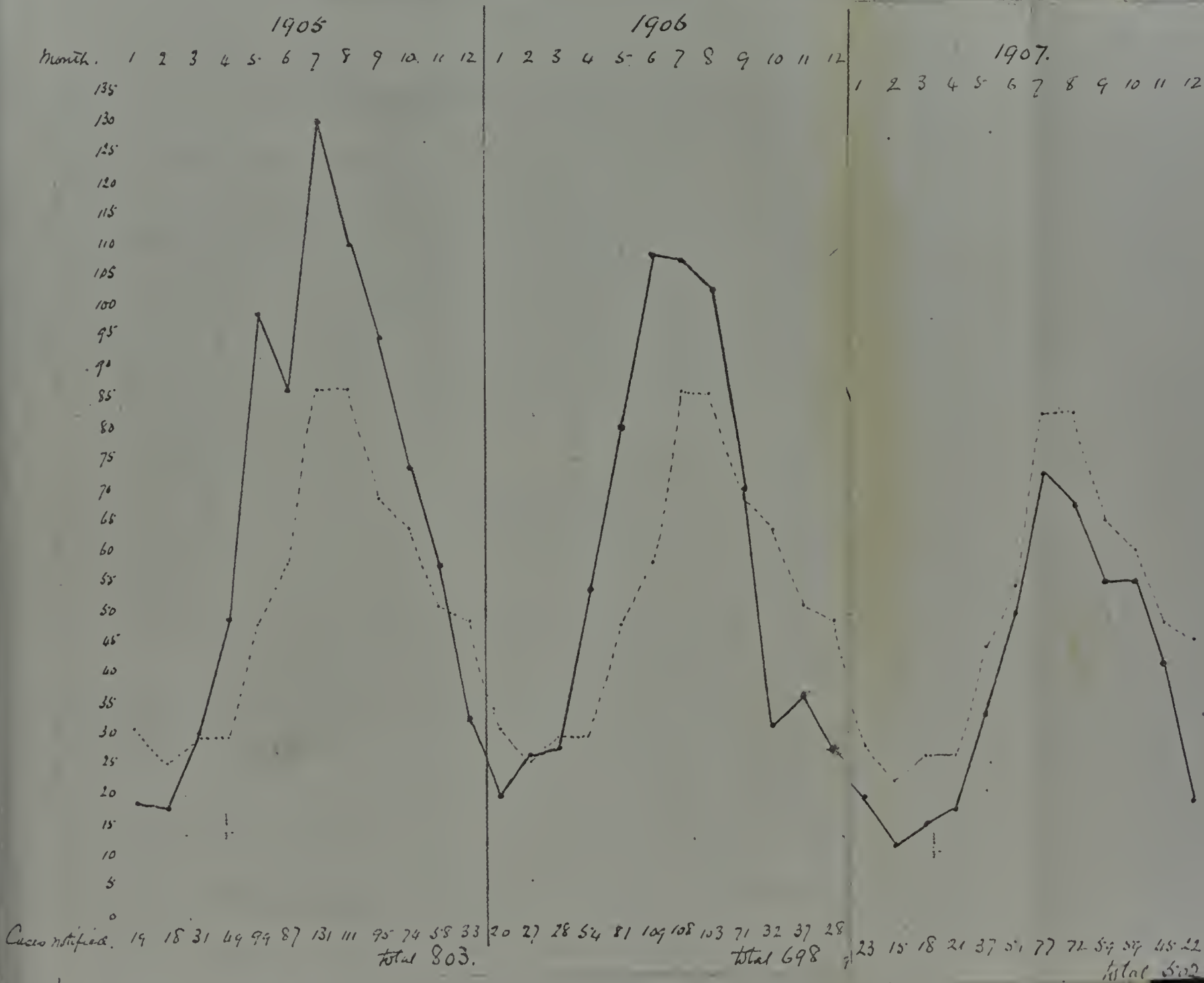
* Readmission.

Comment on the foregoing epidemiological facts is hardly necessary, but by way of emphasising these results of the supervision of milk supply it is interesting to examine the civil statistics for the corresponding period.

The Maltese are still unbelievers in the "milk theory" and in spite of the circulation by the Chief Government Medical Officer of pamphlets in English, Italian and Maltese pointing out the danger of unboiled milk the great mass of the people like to think that what was good enough for their forefathers is good enough for them. The educated classes are quite alive to the situation, but where such a big question as the livelihood of a great section of the people is involved they must move slowly and cautiously, and dare not face the risks of a too precipitate legislation. The following chart (51) shows the incidence of the Fever amongst the Civil population for the years 1905-6 and 7 compared with the average for the years 1896 to 1905. It will be seen that though 1907 shows a marked decrease compared with 1905 and 6 yet it is practically an average year.

201.
Chart 51

Showing the monthly admission rate for the years 1905-6 & 7
for Maltā Fever amongst the Civil population of
Maltā.



The dotted line shows the average monthly admission
rate for the years 1896-1905. The annual average is 632.

This Chart (51) should be compared with Charts 49 (Naval) and 50 (Military) and nothing more conclusive is required to prove the efficacy of the prophylactic measures adopted in these two latter cases.

It should be noted that Horrocks attributes the disappearance of the Fever ("Rock Fever") from Gibraltar to the fact that goats are not now shipped to the Rock as they used to be in the eighties, and that it has been gradually stamped out in a place which is under strict military supervision.

CONCLUSION.

It is gratifying to be able to wind up a work of research by showing such results as the above. We hope that as far as the Navy and the Army are concerned we shall have complete control over the disease even if it be not absolutely wiped out from the Medical Blue Books. Looked at from an economic point of view the saving to the State during the past year has been enormous. The average number of cases occurring in both services amongst the officers and men during the ten years previous to 1907 has been about 600, and allowing the average length of stay in hospital to be 120 days (a moderate allowance) there are 72,000 days of inefficiency accounted for in each year.

not to mention the expense of treatment and invaliding home and the loss to the State in permanent invalids. In 1907 the total number of cases under treatment was only 25 in both services,- only 4 per cent of the previous annual average.

Therefore the result of this elucidation of the cause of Malta Fever has been of great benefit to the State in that it has considerably reduced expenditure and has increased the efficiency of the Mediterranean Forces, and the Mediterranean is no longer one of the most dreaded of foreign stations by the Naval and Military man.

Post-script.

Post Script

In view of my remarks (vide pp. 2 & 206) on the opinions expressed by Maltese on the subject of Malta Fever, I attach a reprint from the *Ram. J.* Journal which draws attention to these opinions with some effect. In so doing I trust that it may not be considered out of place nor that I be accused of levity. The extract from "The Maltese" on page 3 of the reprint is what I desire to draw attention to, and, besides being amusing, undoubtedly reflects the opinion of a great majority of the people.

*Reprinted from the JOURNAL OF THE ROYAL ARMY MEDICAL CORPS,
December, 1907.*

A LITTLE HUMOUR FROM THE MALTA FEVER COMMISSION.

BY CAPTAIN J. CRAWFORD KENNEDY.
Royal Army Medical Corps.

I FEEL that the title of this communication needs an explanation and perhaps an apology to the author of "The Humour of Indian Sanitation"; but it will be observed that my intention is honest. Hints have been dropped from more than one quarter that the Reports of the Mediterranean Fever Commission were too deeply scientific to appear as full reprints in our Journal. It has therefore occurred to me that I could supply some little bits of humour which might, to some extent, counterbalance the depressing effect which these reprints appear to have had.

The origin of Malta fever has been the subject of many theories, but one of the weirdest is propounded in the following letter to the *Daily Malta Chronicle* of October 21st, 1903.

"MEDITERRANEAN FEVER.

"SIR,—From the number of deaths which are attributable to the well-known Mediterranean fever from day to day, it is apparent that the disease still baffles the skill of the medical profession.

"As patients afflicted with this dreadful scourge are found to regain their health most speedily when transferred to a different region of the Earth, and as the complaint seems to originate in places adjacent to the Sea, the cause of the trouble may reasonably be attributed, I think, to the intensely bluish sheen of this fine sheet of water, and the corresponding colour of the atmosphere. This idea is not so far-fetched if it is borne in mind that the blue rays of sunlight are now known to have a most injurious effect in such diseases as small-pox. It would, however, be easy to test if there is anything in this idea, by giving a few of the fever patients a chance of recovery in a ward where the light would reach them only as filtered through glass of the colour used by photographers in their dark room lamps, say. Of course, if this peculiar fever has been known to attack blind people, then the cause must be sought for on other lines.

"My theory is that Mediterranean fever originates in a disorder of the optic nerves, caused by the superabundance of intensely blue light, accompanied by the peculiar glistening effects of the water, which effects are like occasional small currents of bright electrical fluid confusing and dimming the eyesight. This effect is most

troublesome when the system is weakened generally, or after
of unusual exertion.

“ *Malta,*

“ METEOR.

“ *October 20th, 1903.*”

If a Maltese be asked the cause of the fever, the chances are that he will loudly accuse the drainage system. Drainage and water supply waste money, and his old plan was much more comfortable, viz., cesspits and wells. These cesspits were hewn out of the soft porous rock of which Malta is almost entirely composed, and were usually situated underneath one of the living rooms. As the rock is so porous the fluid part of the sewage soaked away and a modification of the septic tank process was the result. These cesspits would perform their function for years and years without being emptied. When the sanitary authorities ordained that all new cesspits should be lined with cement they had to take precautions to prevent the energetic householder descending with a pick to crack the cement, so devoted was he to his “self-emptying” (and economical) cesspit.

It is now common property that the goat is at the bottom of most of the fever. Under the very close attention paid to the goats by the investigators the owners of the goats became restive and rebelled, and finally went on strike. They forewarned the public by issuing a Proclamation headed

“ No more milk !

We can't bear it any more !!

We can't do any more !!! ”

and signed, “ The Vexed Maltese Milkman.”

As this wonderful Proclamation was reprinted in full in the Corps News of July, 1906, under “ Notes from Malta,” I need not repeat it ; but the apostrophe of the goat is quite a unique thing in the way of a public Proclamation : “ Poor Maltese Goat ! What a war has been waged against her ! How she has been humbled all over the world as a filthy and poisonous animal ! ”

The following extract from a letter sent to me by one of the goatherds shows how bitter was the feeling at the time of the milkman's strike. The humour of this letter is in its “ English as she is wrote.”

Extract from Letter.

“ SIR,—I beg you to pardon me the liberty I taken to writing you this letter.

“ SIR,—I have to inform you that the Milk Sellers has recovered that time ago I furnished you with Goat's blood and milk for the use of Medical Experiments, so it is impossible to continue selling

milk as they are all against me, and I am insulted wherever I go, beside this, I also have to spend a sum that I am not able to spend it, regards the new 'Sanitary Regulations,' not if I sell all my goats will be enough to comply with these orders.

"An answer (if possible) will obliged,

"I will remain, Sir, &c."

Of course the milkmen have suffered greatly and it is very hard on them, and legislation is needed for compensation to owners for destruction or quarantine of infected animals. But until the great mass of the people is educated up to the hard facts, and persuaded out of the idea that what was good enough for their forefathers is good enough for them, the Government will hardly see its way to initiate the much needed reforms.

Not only did the members of the Commission incur the hostility of the milkmen, but they were also the subject of scathing criticism in the local papers. The following is a copy of a letter which appeared in *The Malta*. The italics are my own. Comment is needless.

"VALLETTA,

"November 5th, 1906.

"DEAR MR. EDITOR,—In an article which appeared in the servile *Daily Malta Chronicle* (which has not even a shred of self-respect, as can easily be seen by the expressions interpolated in the same article on Malta Fever), the incompetence and levity of this ill-omened Commission has been shown—this Commission which according to the *British Medical Journal* leaves much to be desired both as regards experiments, scientific knowledge on the subject, and logical deductions.

"In fact, on reading that article it is clear that the Commission seem to ignore the fact—known even to the most stupid school boy—that the mere presence of the *Micrococcus melitensis* of Caruana Scicluna-Bruce (*sic*) in our goats' milk does not demonstrate in the least that such milk is the source of infection of the fever, which is not Maltese—*vide* the treatises of the most renowned Italian and French authors, who are the most competent. One must not run away with the idea that every microbe which finds its way into the digestive organs succeeds in infecting our miserable selves; in such a case there would not be a single man living; besides, are we not aware of the fact, expressed by all the Medical Congresses of the civilised world, that, although *the cow's milk overflows with tubercle bacilli*, the same is not a means of infection, for the reason that the bacilli are destroyed in the digestive organs and but very rarely

multiply there. In face of all these facts, well known even to those who do not belong to the medical profession, is it fair and honest on the part of *this most incompetent Commission* to declare that our goats are a source of infection, especially as ——— has declared that such infection is but rare? Is it fair to support this calumny which has caused considerable damage to our commerce with other countries far and near, by two feeble cases of very doubtful infection.

“Have not the people who are receiving such an amount of our money, which is thus being exhausted, have they no common sense? Are they not ashamed to write such ridiculous reports which show their *crude ignorance of the rudiments of bacteriology*? Do they not know that in order that an experiment shall be conclusive it must be absolute—that is to say: in order to declare that a monkey has been infected through the ingestion of milk, it is necessary that other sources of infection shall be absolutely eliminated, that the air breathed by the animal be pure, that it shall not be under the influence of other inoculations, &c.

“Why do not these bacteriologists go back to their homes and suggest to their consumptive countrymen not to drink the milk of English cows, because . . . such milk contains the bacillus of Koch?

“Why is it permitted to these people to alarm honest folk whose health has been broken by a *system of drainage introduced by their countrymen in spite of the remonstrances of the whole of the Maltese population*?

“Why, instead of *inventing Maltese fevers*, do they not suggest to their countrymen not to overtire themselves under the scorching rays of the sun for hours and hours playing the savage game called Rugby? and, immediately after, dipping in ice cold water, or drinking whisky that would burn even a stomach made of marble? These are the suggestions they should make, and not recommend us to spoil milk by boiling, which, while destroying the germs in the milk, destroys also the better qualities of our milk which has always invigorated our forefathers and our children.

“Oh, these people! they know not what is chemistry, nor what is bacteriology.”

Is it not a wonder that the members of the Commission, after such an indictment being hurled at them, can show their faces for shame of the exposure!

This is criticism with a vengeance and quite unanswerable. But what is one to do when confronted with a criticism of a higher

order! A certain learned Theologian, writing to the *Expository Times*, gives an example of the Higher Criticism as applied to the much vexed question of Paul's thorn in the flesh, and comes to the conclusion that the Apostle must have suffered from Malta fever.

He arranges the Scriptural evidences and the clinical symptoms of the disease in parallel columns, one against the other. Thus:—

PAUL'S INFIRMITY.

A stake for the flesh.
Charge of fickleness.
Called a madman.
Buffeting of Satan's angels.
Excitement of contempt and loathing.
Constant impalement and buffeting.
Sentence of death in himself.

MALTA FEVER.

Headache, pain in joints and muscles.
Temporary impairment of memory.
Nocturnal delirium.
Rheumatic like pains and neuralgia.
Crippling and skin eruptions.
Chronic pains, neuralgia, and debility.
Occasional endocarditis or pneumonia.

What do our clinicians say to that for a diagnosis! I am afraid that a mere bacteriologist is not of much assistance in this case. Perhaps some of our specialists in psychology will assist; they would appear to be better able to follow the mental gymnastics of this Higher Criticism.

This communication is now longer than I had intended it to be, and I shall straightway conclude by giving extracts from a letter sent to me by the adjutant of a regiment, in reply to a request that the men be asked to collect mosquitoes and forward them to me in boxes. The men did their duty nobly, and supplied us with more specimens than we could comfortably deal with, but they evidently got good value out of the game. I am afraid that we got a very poor share of the fun—as there is little humour to be derived from the dissection of some hundreds of mosquitoes.

Extract from Letter.

"Fort —, Malta,
—, 1905.

"DEAR KENNEDY,—P. has passed your note on to me, and all our men are now running about with butterfly nets, or trying to tempt the wily mosquito with lumps of raw meat, and I've indented for a small size of mouse trap, but am doubtful if the Government will supply the necessary bait. Up to the present the bag is one, and he struggled so when our Regimental Police were effecting his capture that he had to be hit hard on the head and I'm afraid is almost unrecognisable.

"P.S.—Another capture just reported—we've put him in the guard room till your boxes arrive. He has been biting — — and was consequently drunk and his capture was easy. Ought mosquitoes (when drunk) to have their boots removed?"

A SPECIAL graduation ceremonial was held on October 17th in the new Examination Room, when the following degrees were conferred by the Vice-Chancellor (Principal Sir William Turner, K.C.B.) :

1. James Crawford Kennedy, Captain, R.A.M.C., M.B., Ch.B. Edin., 1900, who was awarded a gold medal for his thesis on Malta Fever.

In presenting a Medical Faculty Gold Medal to Captain James Crawford Kennedy for his thesis the Vice-Chancellor referred to the work he had done, and for the excellence of which he was about to receive this medal. This work, he said, was of the highest importance to the welfare of the British navy and army. It consisted of an inquiry, as a member of the Commission of which one of the university's most distinguished graduates in medicine, Colonel Sir David Bruce, was chairman, into the whole question of Mediterranean fever, commonly called Malta fever, and the mode of preventing this fever. It was a source of great gratification to the members of the university that the chairman of this Commission and Dr. Kennedy were trained in the medical school of the University of Edinburgh and were graduates of the university. The inquiry which these gentlemen had carried out with so much success had practically added the services of a whole regiment to the strength of the British army in the garrison station of Malta, so that in this respect Dr. Kennedy and those associated with him had discharged a most important public service. It was with great pleasure that the Faculty of Medicine had decided to award this medal in recognition of the distinguished merit exhibited in the thesis submitted for the degree of Doctor of Medicine.

A special graduation ceremony was held in the examination-room of Edinburgh University on Saturday, when Principal Sir William Turner conferred the degree of Doctor of Medicine on James C. Kennedy (captain, R.A.M.C.), Scotland, awarded gold medal for his thesis on "Malta Fever," and Francis E. Ladell, England, highly commended for his "Life in a 'Crib or Spinal Fever.'" The degree of Bachelor of Laws was conferred on one gentleman and of Master of Arts on 23 ladies and gentlemen. The Principal, in presenting Captain Kennedy with the gold medal, said his work was of the highest importance to the welfare of the British Navy and Army. It consisted in an inquiry, as a member of the Commission, of which one of the University's most distinguished graduates in medicine, Colonel Sir H. H. Bruce, was chairman, into the whole question of Mediterranean fever—commonly called Malta fever—and the mode of preventing this fever. It was a source of great gratification to the members of the University that the chairman of this Commission and Dr Kennedy were trained in the Medical School of the University of Edinburgh and were graduates of the University. The inquiry which these gentlemen had carried out with so much success and practically added the services of a whole regiment to the strength of the British Army in the warlike station of Malta, so that in this respect Dr Kennedy and those associated with him had discharged a most important public service. It was with great pleasure that the Faculty of Medicine had decided to award this medal in recognition of the distinguished merit exhibited in the thesis submitted for the degree of Doctor of Medicine by Dr Kennedy.

AMERICA'S EUROPEAN
TRADE

Mr Henry Seson Karr, would not authorize or
frustrated his acceptance of the nomination, and
his desire and intention to do all in his power
to forward the interests of Union in the
emergency.

EDUCATIONAL

A special graduation ceremony was held on Saturday forenoon in the new Macdonald Hall of Edinburgh University, when the following degrees were conferred by the Vice-Chancellor (Mr. William Turner, M.C.B.):—

The Degree of Bachelor of Laws - LL.B.
Bachelor of Laws - LL.B.

[illegible]

In presenting a Medical Faculty diploma to Captain J. Crawford Kennedy, LL.M. Q. for his thesis on Malta fever, the Vice-Chancellor referred to the work which Captain Kennedy had done and to the excellence of which he was about to confer this medal. This work, he said, was of the highest importance to the welfare of the Mediterranean Army. It covered in an inquiry, which was the Commission of which one of the University's most distinguished graduates in medicine, Sir David Bruce, was chairman, the history and question of Mediterranean fever, especially in Malta fever, and the mode of prevention of the same. It was a source of great gratification to the members of the University that the Commission, the Commission and Dr Kennedy were composed of the Medical School of the University, and that they were graduates of the University. The work, in which these gentlemen had co-operated with so much success, had practically equipped the whole regiment, to the strength of the British Army in the partition station of the Mediterranean, to the rescue Dr Kennedy, and the Vice-Chancellor, had so charged a new era in the history of medicine, and with great pleasure the Faculty of Medicine had decided to award him this recognition of the distinguished merit exhibited in the thesis submitted for the degree of doctor of medicine.

The End.

12th October, 1919.

Sir,

Dr. Conway's interesting article on lymphadenopathy in Brucellosis was of great personal interest to me in view of the extensive work on the subject of Malta Fever, by my father, the late Colonel J.C. Kennedy. He served in Malta from 1901-1906, and was appointed a member of the Malta Fever Commission on its formation in 1904. In 1908 he received the Edinburgh University Gold Medal for his M.D. Thesis on Malta Fever. Parts I and III of this thesis deal with the aetiology, epidemiology, immunity and prophylaxis of Malta Fever, while Part II is a description of the clinical conditions based on the personal observation of 250 cases. The following paraphrased extracts and extracts from this thesis seem to throw some bearing of the question as to whether or not, lymphadenopathy occurring in a patient with Brucellosis is a specific manifestation of the disease. -

- 1) Under the section dealing with aetiology and experimental pathology, I have paraphrased for the sake of brevity, the following findings.--- The experimental inoculation of *Micrococcus Melitensis* into a monkey and two dogs caused enlargement of the spleen and certain lymph glands, 20-60 days after the inoculation - *Micrococcus Melitensis* was recovered (in profusion) from the mesenteric, femoral and axillary glands in the case of the monkey, and from the inguinal and axillary glands in the case of the two dogs.
- 2) Under lymphatic vessels and glands on page 104 in the description of symptoms by systems is the following paragraph.--- "All the lymphatic glands are slightly enlarged and those lying in the neck posterior to the sternomastoid muscle become tender very early in the disease. - The glands are the last organs on the body for the *micrococcus* to leave (see morbid anatomy) - lymphangitis has occurred in one case in both legs with enlargement of the popliteal glands".
- 3) The following paragraph occurs under the heading of Postmortem Bacteriology --- "The organism, *micrococcus Melitensis*, is recovered from the following organs in the greatest profusion in order of precedence - lymphatic glands (when fluctuating), spleen, liver, bone marrow, kidney. The observation that the lymphatic glands were so favourable to the recovery of the organism (Kennedy - Malta Fever Reports IV) was of the greatest value from an experimental point of view, as it was proved that the organism remains in these organs long after it has disappeared from all other parts of the body. Therefore it became routine practice when making post-mortem examinations on experimental animals to make cultures from several of the glands. In many cases it was the saving of the experiment when these organs were the only ones containing the *micrococcus*".

In 1906, as a result of the findings of the Malta Fever Commission, the consumption of unpasteurised goats milk was prohibited to all British service personnel. Prior to that date the average incidence of Malta Fever in the Malta Garrison alone was in the region of 600 cases yearly. Since 1906 the incidence

of Malta Fever in the Garrison has for the most part, been only sporadic. For this reason, it is probable that there will never again be such a wealth of material available for investigation and analysis. It is on these grounds that I submit the above extracts

It may interest your readers to know that it was Colonel J.C. Kennedy, who in January 1914, provided the first clue that cows milk might produce undulant fever in humans, when he reported the presence of agglutinins for the micrococcus *Melitensis* in the milk and blood serum of cows in London. - (1) Unfortunately, due to being posted overseas, he was unable to follow up this observation. It was four years later in 1918, that Miss Alice Evans showed that these agglutinins found in the milk and blood serum of cows were due to infection by the closely allied *Brucella Abortus*.

I am, etc.

M.S.K.

M.C.S. KENNEDY.

(1) Kennedy J.C. 1914. Journal of the Royal Army Medical Corps.

Letter published in B.M.J.

No 4636 12th Nov. 1949

To:-
The Editor,
British Medical Journal,
Tavistock Square,
London, W.C.1.

London S.W.

24

Foreign Stations (A.M.D.2)

14th June, 1907.

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Sir,

I am directed to acquaint you that a communication has been received from the Royal Society bringing to notice the services rendered by the Officers of the Royal Army Medical Corps in the investigation into the cause of Mediterranean Fever. The Society expresses its high appreciation of the value of the services performed by those Officers and states that it is mainly owing to their efforts that the investigation has been so complete and successful.

I am to state that this letter has been received with much gratification, and to request that you will inform Lieut.Colonel A.M.Davies, Major J.C.Weir, and Captain J.C.Kennedy, R.A.M.C., that a note of it has been made in their records of service.

I am,
Sir,

Your obedient servant,

The General Officer Comdg.

London District.

(Sd) J.M.Erwin.Lt.Col.
for D.G., A.M.S.

2.

Captain J.C.Kennedy R.A.M.C.

The foregoing is forwarded for your information and retention.

E.P. Sewell
Capt. R. A. C.

London.W.C.

Colonel.

18.6.1907.

for P.M.O., London District.

Welcome Library
for the History
and Understanding
of Medicine



Illustration

The Menstrual

D. Bruce

Illustration

The Menstrual

Illustration

